POWER PLANT ENGINEERING

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Centralizing Power Production

OPERATION OF DUAL DRIVEN AUXILIARIES, INDUCED DRAFT AND MODERN COAL AND ASH HANDLING EQUIPMENT FEATURES OF CROMBY STATION OF PHILADELPHIA SUBURBAN GAS & ELECTRIC CO.

IN REVIEWING THE DEVELOPMENT of public service companies serving more or less extensive territories, we find, first, the acquirement of numerous plants and their distribution systems, then the gradual interconnection of such systems so as to form a whole, and finally the centralization of power generation. Whether one or more than one plant is used to provide energy for the entire system, the location of such plant or plants is largely a matter of economics based upon conditions existing in the particular case. In some instances where such evolution has occurred, we find but a single station taking the place of a number of abandoned plants, while in other cases one or more new plants are constructed with some of the older ones held in reserve. This is particularly true where hydro-electric plants furnish energy during a portion of the year.

Location of the main generating station is a matter of local consideration, and while, from an engineering point of view, it is desirable to place such plants as near the center of gravity of the load as is possible, economic considerations frequently necessitate locating the main plant or plants at such points as will insure adequate and abundant supplies of fuel and water for boiler feed and condensing purposes.

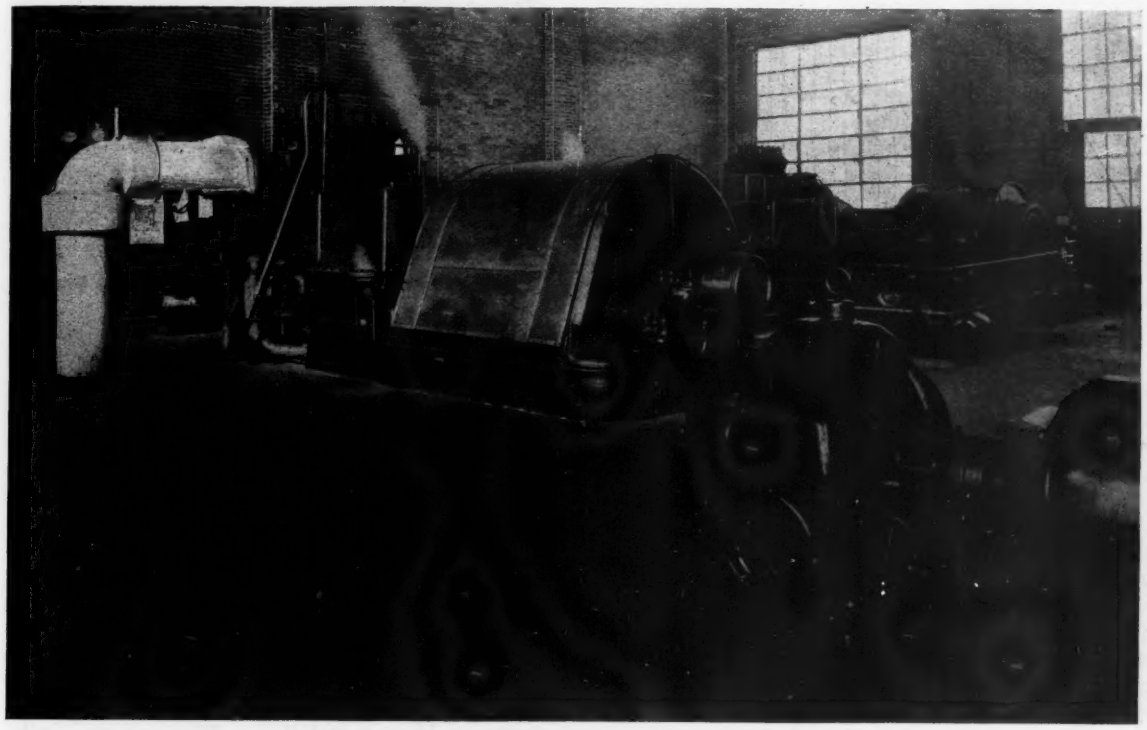


FIG. 1. GENERAL VIEW OF TURBINE ROOM

One of the largest companies supplying electric energy for light and power to a portion of the territory immediately adjacent to the city of Philadelphia, Pa., is the Philadelphia Suburban Gas & Electric Co., the principal communities supplied being Phoenixville, Pottstown, West Chester and Coatesville. At present, small steam plants are operated at Phoenixville, Pottstown and West Chester, all of which feed into a common system of high-lines so connected as to allow an interchange of energy with other stations located at Downington, Norristown and Reading.

Due, however, to the fact the three small stations operated by the Philadelphia Suburban Gas & Electric Co. have not only been found of insufficient capacity to meet present day requirements, but are more or less obsolete, a new and modern steam operated plant, erected at Cromby just outside of Phoenixville, was placed in operation May 5, 1918. Essentially this is a feeder station, but on account of its close proximity to the Schuylkill River and the coal fields for Pennsylvania, the site selected has proven ideal for the purpose.

An exterior view of the power house is shown in Fig. 2. Of steel, concrete and brick, the structure

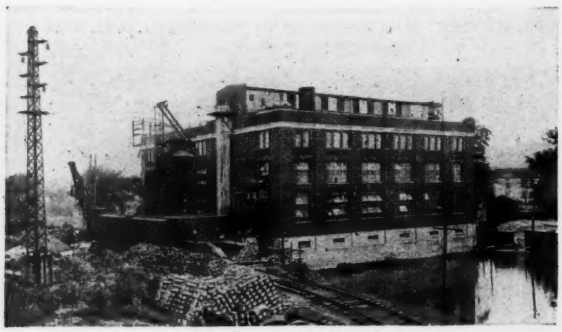


FIG. 2. EXTERIOR VIEW OF CROMBY PLANT, SHOWING ASH HANDLING EQUIPMENT

which, except for a basement extending below both boiler and turbine rooms, is but a single story in height, occupies a ground space of approximately 119 by 146 ft. And, with the layout of equipment and scheme of arrangement employed, either boiler room or turbine room, or both, may readily be extended at any time in the near future the capacity of the installed equipment should prove inadequate to meet the demands placed upon it.

Exterior walls are faced with a reddish brown brick, while salt glazed brick is employed on the inside walls; with the combination of dark brown for the lower sections and buff for that above, the walls of the turbine room present both a very pleasing and a clean appearance. Flooring throughout the station is of concrete, thus rendering the structure fireproof throughout.

Coal and Ashes Handling

Coal is the fuel used, and as shown in Fig. 8, is delivered in bottom dump cars which deposit it into a 10 by 12-ft. steel plate hopper suspended by means of a pair of 20-in. I-beam track girders. It is then fed to the crusher by a reciprocating feeder consisting of a steel plate with 18-in. retaining walls and actuated by an eccentric on the crusher roll shaft, the degree of feed being regulated by the length of the stoker. The crusher is of the standard roll type and like the rest of the coal and ashes handling equipment was furnished and installed by the R. H. Beaumont Co. Rolls with chilled rims are employed and are mounted on 4½-in. shafts, one of which is carried in rigid bearings and the other, to avoid injury to the rolls in the event some foreign matter of considerable size should find its way into the crusher, is carried by spring relief bearings.

Operation of the crusher is accomplished by means of a 10-hp. electric motor running at a speed of 1150 r.p.m., and fitted with a cast steel pinion meshing with gears of hard cast iron.

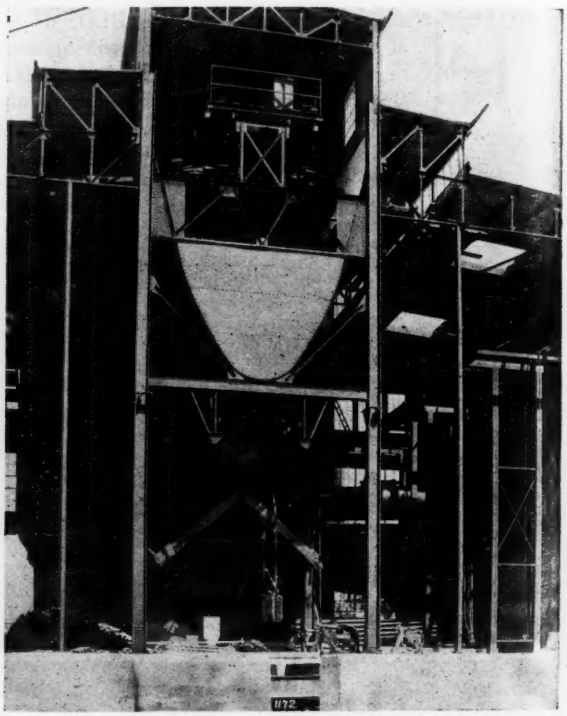


FIG. 3. BOILER ROOM UNDER CONSTRUCTION, SHOWING PART OF CONVEYING APPARATUS, BUNKER AND WEIGH LARRY

From the crusher the coal passes to an overlapping pivoted bucket conveyor or Jeffrey carrier, consisting of a series of 18 by 24-in. buckets placed and carried between two strands of 24-in. pitch double bushed steel side bar chains which carries it to the overhead bunkers shown in Figs. 3 and 9. A 10-hp. electric motor is installed to drive this part of the equipment, and in order to insure proper distribution of the fuel, automatic tripping devices have been provided.

Corrugated sheet iron, covering a framework of steel, encases the vertical run of the bucket carrier. The horizontal run is supported by cast-iron strands on structural steel supports.

Of steel plate suspended type, with ¼-in. bottom plates and 5/16-in. girder plates, the coal bunker is supported by means of cross girders placed between the building columns. Nine gates of the Beaumont-larry-operated simplex type, 12 in. square, are provided.

A 3-ton traveling weigh larry feeds the coal to stoker hoppers, and in order to facilitate the keeping of accurate station records of the amount of coal fed each boiler, the scale beam is fitted with an automatic ticket recording device. The larry, which is driven by a 3-hp. electric motor readily controlled from the boiler room floor, can deliver coal to either row of boilers.

The car and skip system is employed in connection with the ashes handling machinery. Two scoop cars,

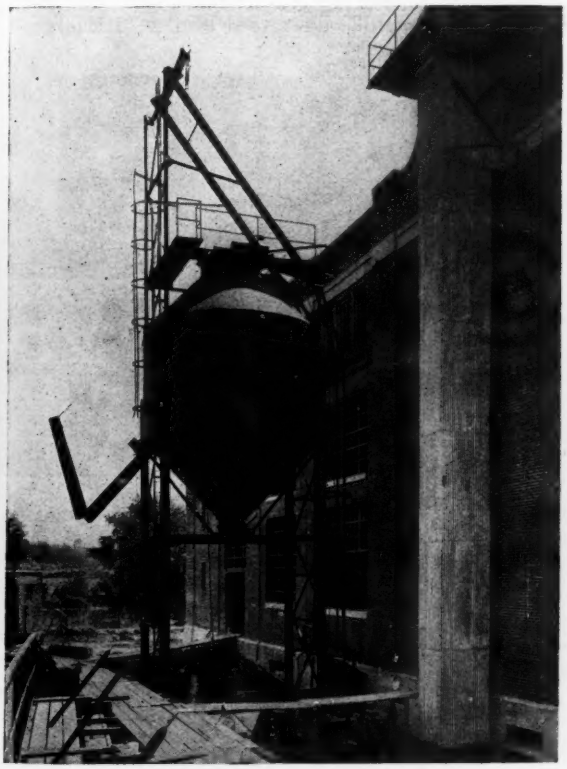


FIG. 4. ASH RECEIVING BUNKER

each with a capacity of 18 cu. ft., collect the ashes from the brick lined hoppers under the boilers and deliver them to a skip bucket having a capacity of 40 cu. ft. In being elevated to the bunker, the bucket is guided first by steel angle guides supported by the bunker columns, and above the bunker by channel tracks. Dumping is accomplished by means of steel plates, the front wheels of the bucket being guided by the plates, while the rear wheels continue along the channels.

Reference to Figs. 2, 4 and 5 will assist in a more ready understanding of the construction and operation of this part of the equipment. The cylindrical ash bunker, which has a capacity of approximately 4000 cu. ft. and is lined with a 1½-in. thickness of cement plaster laid on wire netting, is fitted with a hinged cover operated by the skip bucket.

Final disposal of the ashes may be by either rail or wagon, the arrangement being as indicated in Fig. 4. The gate opening to the railroad cars is of the rack and pinion slide type, while that employed in conjunction with the steel chute used to deliver the ashes to wagons or trucks is of the 24-in. cast-iron duplex type.

Water Supply

A small stream in close proximity to the station has been dammed to provide water for boiler feed purposes, the supply available from this source being estimated sufficient to care for an installed plant capacity of approximately 10,000 kw. The pond formed is on the west side of the power house and is formed by a natural earth

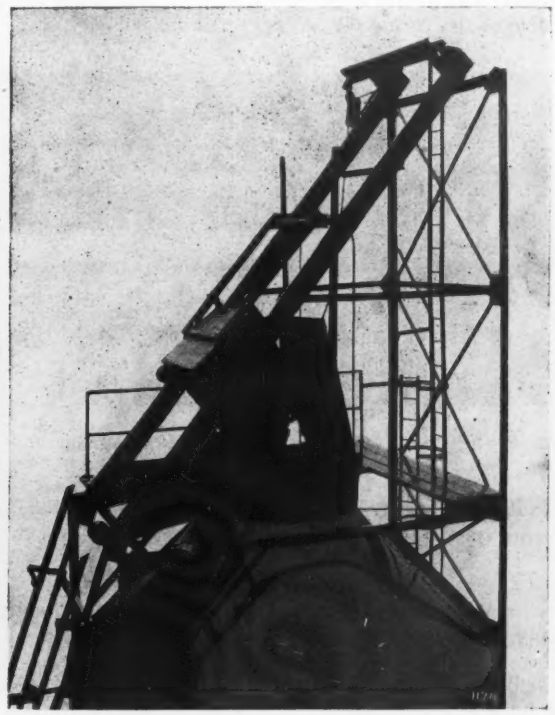


FIG. 5. METHOD OF DELIVERING ASHES TOO BUNKER

depression, with the north wall of the structure basement acting as a retaining wall.

Any additional water which may be required for boiler feed purposes is taken from the Schuylkill River, but before being used is treated by means of the soda-ash and lime process in a Sorge-Cochrane feed water heating and treating plant supplied by the Harrison Safety Boiler Works.

Water for general house service is also taken from the pond, the suction lines for this, as also those for boiler feed service, being equipped with twin strainers of the Elliott type.

Two 350-gal.-per-minute Worthington triplex power pumps so connected as to take water from either the hot well or the cold well, and each driven by a 30-hp., two-

speed Westinghouse motor, are installed for general house service work.

Make-up pumping equipment consists of four units. Two of them, used under ordinary conditions of operation, have capacities of 600 gal. per minute each, and while one is steam driven, the other is direct-connected to a 30-hp. electric motor; the others used only during light-load periods, have a capacity rating of 300 gal. per minute each and are equipped with similar driving units as are the larger machines.

Heating of the feed water is accomplished by means of a Cochrane metering heater, and after the water has been heated to the temperature desired, it may be delivered by any one or all (depending upon operating conditions) of three Worthington centrifugal pumps driven by Terry single-stage steam turbines equipped with excess pressure regulators. Two of these pumps have a capacity of 350 gal. per minute, while the other is capable of delivering 600 gal. per minute.

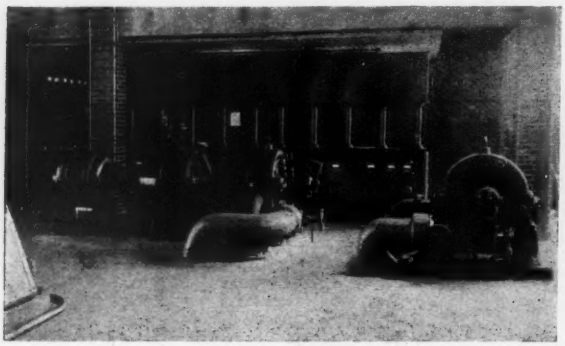


FIG. 6. REAR OF BENCH BOARD AND TURBINE-MOTOR-DRIVEN EXCITERS

Regulation of boiler feed is under the control of Copes type BI and Williams feed-water regulators.

Steam Generating Equipment

Although provision has been made for eight boilers, only six have up to the present time been installed, with the entire boiler plant designed to carry loads equivalent to 200 per cent rating continuously and 300 per cent for 4 hr. Three of these are of Keeler make, each with a horsepower rating of 713 and three are of Edge Moor make, two of which are capable of developing 981 hp., while the third is designed for 732 hp. The Keeler boilers are built for a working pressure of 225 lb. gage, that ordinarily maintained, and the Edge Moor units for 235 lb. gage; all are fitted with Foster superheaters designed for superheating the steam 125 deg. F. and Taylor automatic type AA6 stokers. Those under the 713-hp. Keeler boilers are each of the eight retort type, with a similar one under the 732-hp. Edge Moor unit; the other two Edge Moor boilers are each fitted with an 11-retort stoker.

All boilers are equipped with settings made up of 9-in. fire brick walls and 9-in. red brick walls separated by silocel blocks for insulation.

In addition to such auxiliary apparatus as Wright high-and-low water columns, Ashcroft steam gages and Everlasting and Edward master blowoff valves, General Electric flow meters, Hays CO_2 recorders and Ellison draft gages have been provided for each boiler. The instruments have been mounted on individual panel boards which are under the control of a boiler room chief operator, who directs the operation of the boilers according to existing load conditions.

Another panel carries a complement of steam flow meters and recording steam and feed water pressure gages and feed water thermometers, and is used primarily in conjunction with the station auxiliary equipment.

Air supplied the stokers is delivered through a duct 5 ft. side and 6½ ft. high, carried below the boiler room floor and arranged as shown in Fig. 8. The two fans used for this purpose were furnished by the Green Fuel Economizer Co., and are of the double inlet full-housing, ¾ type with angular downward 30 deg. discharge de-

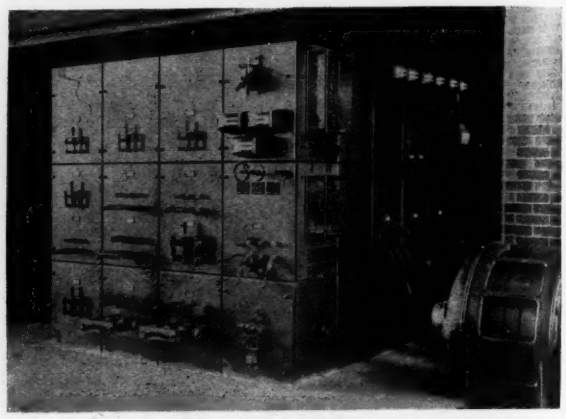


FIG. 7. LOW-VOLTAGE DIRECT-CURRENT SWITCHBOARD

signed to deliver 84,000 cu. ft. of free air per minute against a discharge pressure of 6 in. of water, when operating at a speed of 850 r.p.m. Each of the fans requires about 122 hp. furnished by Terry type G steam turbines through the medium of reduction gears.

A third unit of like type and capacity has been installed for emergency and standby service.

Except for the driving motors, the induced draft equipment was built and furnished by the American Blower Co. Individual fans discharging to the atmosphere through short steel stacks having diameters of 7 ft. for the small boilers and 10 ft. for the large units are provided for each boiler, the arrangement and method of mounting being as shown in the sectional view of the boiler room, Fig. 9. Those used in conjunction with the small boilers are of the double-inlet type designed for a maximum capacity of 60,000 cu. ft. of air against a water gage pressure of 2½ in., while the larger ones, those used with the 981-hp. boiler, are also of the double inlet type with a rated capacity of 88,000 cu. ft. of air when discharging against 21 in. of water. The former are driven by 40-hp. motors and the latter by 75-hp. motors at speeds of 900 r.p.m.

The average temperature of the gases handled is 600 deg.

Main Generating Units and Auxiliaries

The present generating equipment shown in Fig. 1 consists of two 5000-kw. (6250 kv.a. — 0.8 power factor) five-stage General Electric turbo-generators operating at a speed of 3600 r.p.m. and delivering current at 13,200 v., three phase 60 cycles. Each of these is equipped with a Westinghouse-Leblanc jet condenser capable of maintaining a vacuum of 28 in. when condensing 83,300 lb. of steam with cooling water of 70 deg. F. fitted at one end with a 200-hp. Westinghouse induction motor and at the other end with a Westinghouse steam turbine, drive being through the medium of reduction gears.

load and in that manner increase the supply of exhaust steam delivered to the feed-water heater. After the temperature of the water has reached 210 deg. F., the thermostat again operates to close the circuit supplying current to the motor, thus causing this driving unit to pick up the load.

The governor valve on the turbine is set so that when the motor is operating at synchronous speed it will be entirely closed, supplying no steam to the turbine. To accomplish this, it is necessary to adjust the turbine governor so that the speed of the turbine is about 20 r.p.m. below the synchronous speed of the motor.

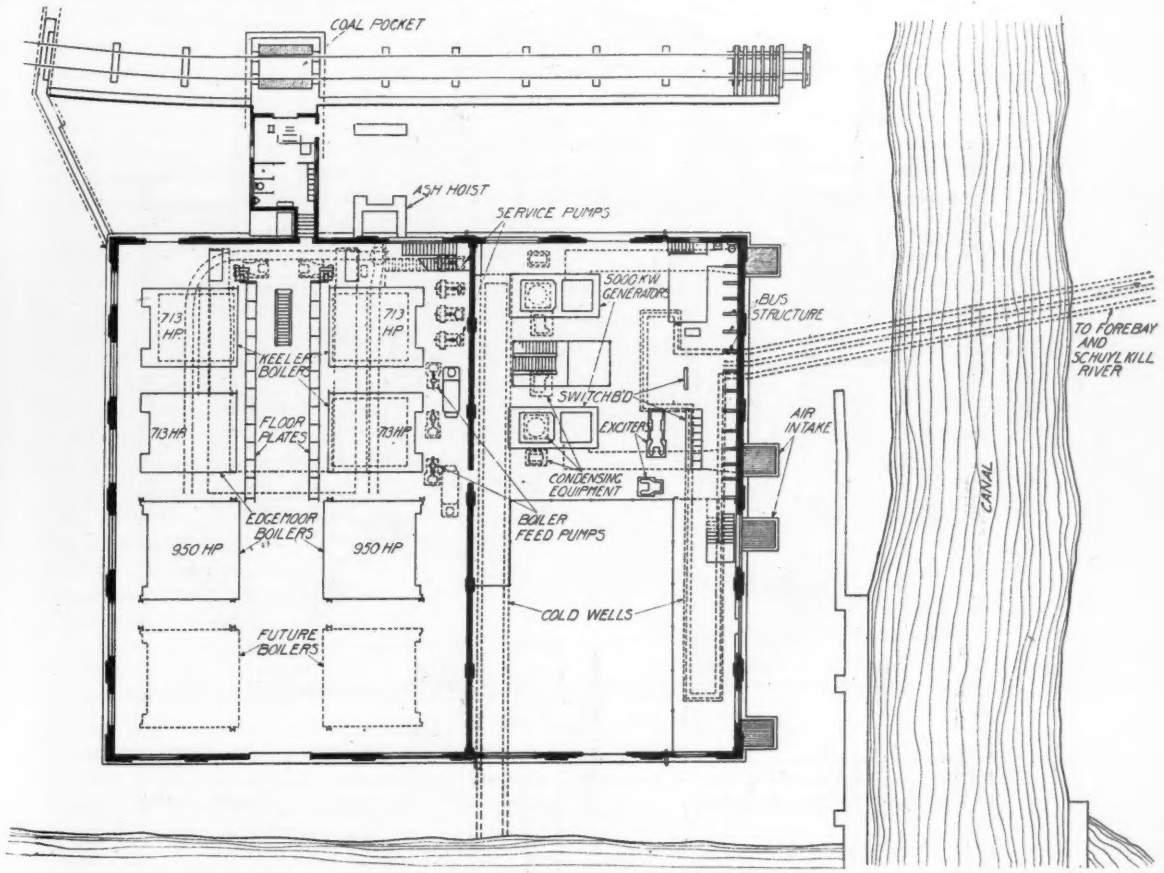


FIG. 8. GENERAL LAYOUT OF CROMBY STATION

Current for excitation purposes is obtained from either one or both of two 50-kw., 125-v. machines capable of being driven either by an electric motor or a Terry steam turbine. This equipment is shown in Fig. 6.

Scheme of operation employed in connection with one of the exciters and both condensers is quite unique, the turbines being run only during such periods as a demand for exhaust steam for the heating of the feed water may exist. When the feed water temperature drops below a predetermined point, 205 deg. F., the electric circuit supplying current to the motor end is interrupted by means of a thermostat installed in the feed-water heater and connected to a contactor carried in the motor circuit, thus allowing the turbine to pick up the

One thermostat is installed for each unit and these like the contactors are the product of the General Electric Co.

Compensators are provided so as to allow the driving of the machine by motor only, thus insuring continuous operation should trouble develop within the turbine or in the case of the condensers in the gearing between turbine and pump.

Piping and Valves

High pressure superheated steam lines and a saturated steam header used in conjunction with the steam-driven auxiliaries are interconnected by means of a cross-over connection from the superheated steam header. All

high-pressure piping 6 in. in diameter and larger is fitted with welded joints.

All high-pressure valves used, including automatic non-return stop and check valves on the boilers, are of Edwards make; on all small steam piping and boiler feed lines Edwards double-tight type joints are employed.

Low-pressure lines are fitted with Crane Co.'s low-pressure valves.

Electric Control and Distribution

In Fig. 7 is shown the direct current board which cares for not only the exciter, exciter motors and voltage regulators, but also the station auxiliary electrical equipment which is operated by alternating current. This is delivered to the motors at 440 v., transformation from the high voltage lines being by means of either one of two banks of transformers having a rating of 600 kv.a. each. The bank not in use is held in reserve for emergency.

All high-voltage oil switches which are of type H_3 motor operated General Electric make are under remote control, current for this purpose being furnished by a 68 amp.-hr. 60-cell D7 Exide battery.

The bus structure is located directly above the chief engineer's office and the switchboards shown in Figs. 6 and 7. Four feeders, each in duplicate, leave the station, and in order to insure continuity of service, each set of feeders is tied in with an individual set of bus bars, each of which, however, may be connected to the generator as occasion may require.

Plans of construction were executed by the engineering staff of the Philadelphia Suburban Gas & Electric Co., D. S. Miller in charge of design work and W. G. Mervine, superintendent of construction. It is the latter and C. W. Taggart, general manager, to whom we are indebted for assistance rendered, making possible the preparation of this article.

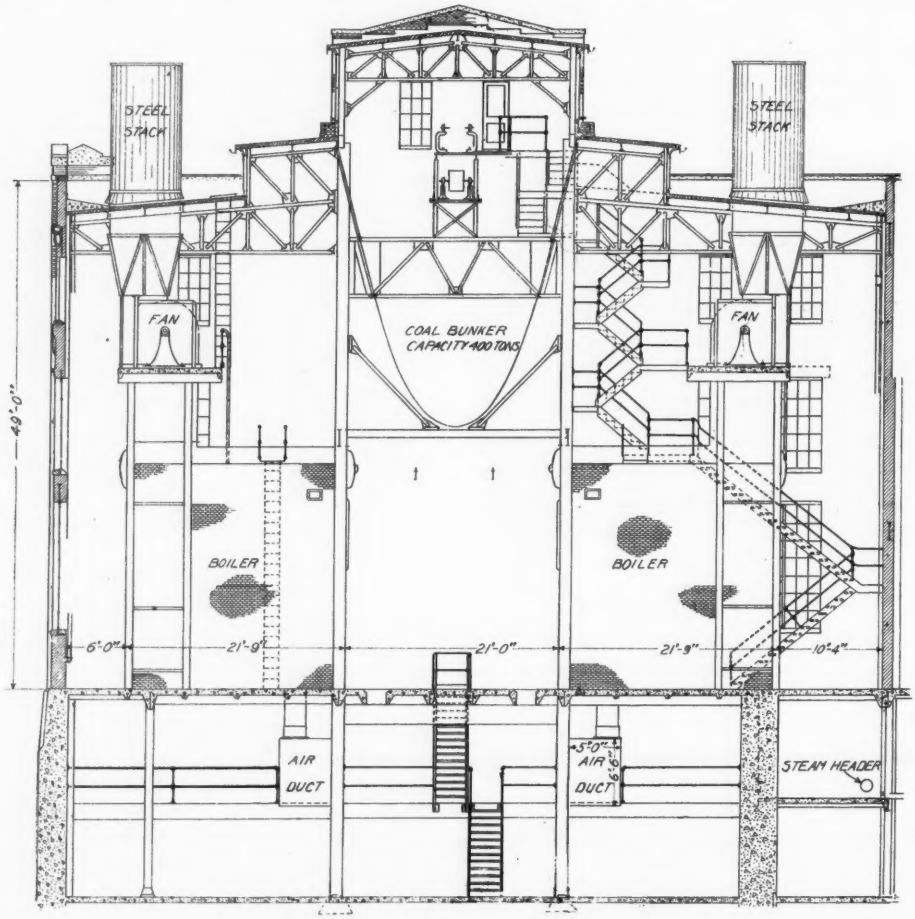


FIG. 9. SECTION THROUGH BOILER ROOM

Next season the Brandy City (Nevada) Mining Co. intends to construct the largest restraining dam in the state, so that it can hydraulic its immense gravel holdings at Brandy City.

The barrier will stretch a quarter of a mile across the North Yuba River, below Bullard's Bar, and will be 150 ft. in height.

The dam will back up water and debris for a distance of nearly 7 mi. along the river, and titles to property that will be affected have been secured.

It is planned to erect near the dam a big power plant which will generate electric power for operating the machinery.

Saving and Returning Drip Water

WHERE DRIP TAPS SHOULD BE MADE; METHODS EMPLOYED FOR RETURNING CONDENSATE; UTILIZING OILY DRIPS. BY WILLIAM E. DIXON

THE MOST neglected matter in mill and power plant piping is that of drips and returns. Books usually dismiss the subject with a paragraph. Distinction may be made between wet and dry returns, and high and low pressure drips, and there the matter ends for the high-brow. He can devote pages to the consideration of exactly the correct per cent of CO_2 to expect, but not a sentence as to where steam lines should be dripped. Yet it should make upwards 12 per cent difference to the coal pile whether you put the drips back or use pure cold water. What is 12 per cent of your daily coal consumption? And notice that word pure. Can you get pure water from the pond? Pond and river water usually contain more or less scale forming material. If you are blessed (?) with such water, it will be enough for the purpose of this discussion to point out that drips are free from scale forming material. And you will agree with us that the subject of drips and returns deserves more than a passing notice.

But if the high-brow seems to hold the matter in contempt, the "practical man" seems bent on making a joke of it. He "returns" the drips to the sewer or the river. If the trap does not work to suit, he opens up the bypass and "lets her sizzle." The writer remembers seeing, some years ago, an oil separator on an engine exhaust line, the drip from which consisted of a space nipple and a gate valve plus a 14-qt. pail. The pail hung from the stem of the gate valve, and as the matter recurred to his attention, the engineer opened the valve and drained the separator.

It may be unjust, however, to charge all the jokes to the low-brow. Designers are not entirely free from guilt. In the power plant of a very large mill, the steam header, 12 ft. above the water line of the boilers, was drained into a Holly system instead of directly to the boilers. In another large power plant under similar conditions, the drips were carried to an open heater.

To make steam from water is an easy operation. All we need to do is to make a hot fire. To turn the steam back into water is easier yet. All we need to do is—nothing. The B.t.u's. that we put into the steam do not seem to appreciate their new home. They get away at the earliest opportunity. If somebody can invent a glue which will make those little fellows stick, his fortune is made; for as soon as the heat units in the steam begin to leave, the steam which we spent money and labor to make begins to return to the liquid state. Steam rises from the water in the boiler, strikes the shell, and away go a lot of those pesky heat units, and condensation takes place. As the steam passes out through the valve and steam lead to the header, there is more heat loss and more condensation. The valves and pipes and header may have double extra thick coverings, but go up and sit on them. Do you feel the heat? It comes from the steam. And that means condensation. On its way to engines and turbines the process continues and we insert separators in the line to take care of the liquid in the steam. Or the steam may be intended for drying coils, kilns, heaters, vulcanizers, mangles, cookers, sterilizers. In such case heat is the thing to be desired and we make it as easy as possible for the heat to escape. More condensation.

A dryer full of water would not dry. A separator full of water will not separate. The mere thought of a header nearly filled with water is enough to make one's spinal column vibrate with cold shivers. Therefore, if we wish to be safe, if we wish to make the machinery produce, we must get rid of the condensate in headers, separators, dryers, etc. That is the why of drips.

Knowing WHY, we desire to know HOW. Let us follow the steam from the boiler. The steam pipe as it leaves the boiler stop valve may rise, as in Fig. 1. If so, a drip should be installed at the lowest point possible

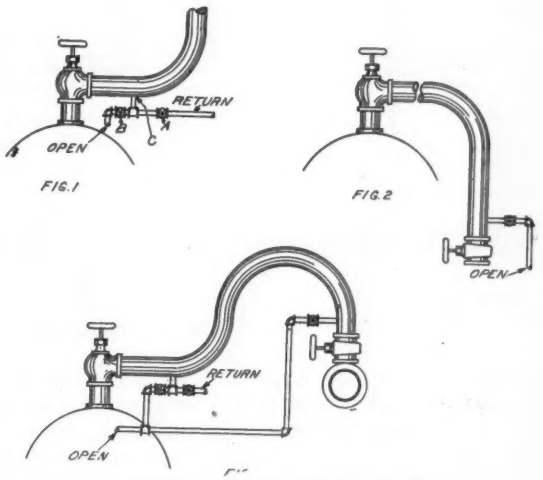


FIG. 1. DRIP FOR BOILER LEAD
FIG. 2. DRIP PIPE AT HEADER
FIG. 3. BOILER LEAD REQUIRING TWO DRIP CONNECTIONS

just outside the valve. (Outside, in this paper, will indicate the side farther from the boiler in the path of steam. Inside will indicate that side nearer the boiler.) This drip has two distinct purposes. While the boiler is in operation, water may collect at C, especially if the valve is automatic. To prevent this, valve B should be closed and A open so as to allow the condensate to drain off to the return system. If the boiler is out of operation, A should be shut and B be open. This being an open ended drip, acts as a telltale in case the header valve is opened and is a safeguard for the man working in the boiler. In cutting in a boiler, it furnishes a guarantee that the line is free from water. The open end must be visible, but to avoid inconvenience and "mess" it should be led to the ashpit or to a floor drain.

The steam pipe may drop all the way from the boiler stop valve to the header, as in Fig. 2. In this case, a

drip should be placed immediately above (inside) the header valve, and should lead away, as in the first case, to a visible open end. No drip is required while the boiler is in operation.

Frequently a third case will be met with—illustrated in Fig. 3. Here the steam main rises from the boiler stop valve, makes a 180-deg. bend and drops to the header. As indicated, the drips should be a combination of those used in cases one and two. The size of these drips should be ½ in.

Next the header. Every fitting should be tapped on the under side for a drip, and a drip should be located on either side of every valve in it. The size of these tappings seem to depend a great deal on whim, ranging all the way from ½-in. to 2-in. The writer favors 1 in. or 1¼-in., according to the size of the installation. Larger pipes lose too much by radiation and smaller ones may not be large enough to handle slugs. Steam headers are being designed much smaller than formerly and this

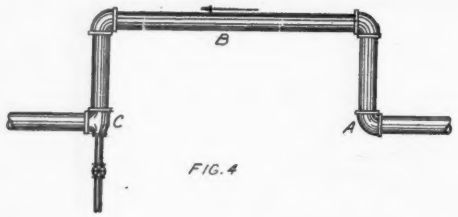


FIG. 4

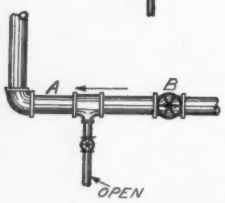


FIG. 5

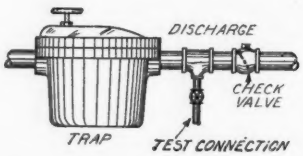


FIG. 6

FIG. 4. STEAM PIPE LINE WITH ELEVATED SECTION
FIG. 5. RISER IN PIPE LINE OUTSIDE THE VALVE
FIG. 6. USUAL TRAP CONNECTION

means less condensate to handle. Directly below the drip connection there should be a stop valve. Gate valves offer less resistance to flow, but globe valves are more easily kept tight and are to be preferred. When there are division valves in the steam header it would seem to be advisable to put a check valve in every drip. These drip lines from various points in the header should lead to a common drip main. The size of this main will depend on the size of the plant, the method of returning the drips to the boilers, and whether or not the steam is superheated. This drip main should not be located directly below the steam header, for expansion difficulties are sure to appear. If the steam header is located 5 ft. or more above the water line of the boilers, the returns may be by gravity, and lines should run from the drip main to every boiler, either through an auxiliary feed line into the boiler drum or into a tee in the blowoff line—inside the blowoff valve. In each of these lines there should be a check valve and a stop valve located close to the boiler connection. In blowing down the boiler, this stop valve should always be closed. If the header is not sufficiently elevated above the boilers to insure return of the drips by gravity, then one of the systems to be described later should be used.

High pressure steam mains lead from the header to engines, pumps, vats, coils, and other apparatus all over the mill. So far as possible these mains should pitch so that the steam flow and natural drainage are in the same direction; but this is not always possible. When it becomes necessary to turn the steam main upwards, a drip pocket should be installed at the beginning of the riser. In a large mill it was decided to install some new machinery in such a location that it would cut the line of the old steam main. It was impractical to make a horizontal loop, so the line was cut and for 60 ft. carried along in the story above as indicated in Fig. 4. It is evident that condensate will accumulate at A and will be carried in a spray up through B and will finally reach the drip at C. But there are some objections to this. Work cannot be had for nothing, and work is done when water is lifted. There is, also, an element of danger. Suppose that steam is shut off for a time, and that the valve leaks. Water will collect at A. Then when the valve is opened again water hammer may result. It is evident that in such a case the drip pocket should have been at A instead of C.

A drip should be located inside of every valve in the steam mains. This will prevent the accumulation of condensate in times when the valve is closed. If the valve is in a vertical pipe with the flow upward, the drip mentioned in the previous paragraph will suffice. If in a vertical pipe with the flow downwards, there should be a drip immediately above the valve. If the valve is seldom shut, it may be well to leave this drip open, and not try to save what little condensate may occasionally be drained from it. In cases of throttle valves, etc., it is usually better to trap the drip and keep the steam pipe clear of water, though there are many places where it would be good practice to allow the water to accumulate and blow it into an open heater or hot well at starting time. It may often be that as much can be saved by letting the pipe fill and thereby cutting down the radiating surface as by the return of hot drips.

Outside every shut-off valve an open drip should be located whenever the line rises beyond the valve. Conditions like that shown in Fig. 5 are common and it must be admitted that many men operate such things and do not get hurt. Luck saves them. Wise men do not trust to luck. It is evident that if the valve B leaks, condensate will collect at A and the opening of the valve is a risky operation. A drip should *always* be located outside the valve B, and this drip should have a visible open end so that the operator may *know* when the line is clear.

Where the pipe size reduces, unless this is done with an eccentric fitting so as to bring the bottoms of the two pipes in line, there should be a drip. It is an excellent idea to locate drip pockets at intervals. These may be formed by installing a tee looking down or by use of a tee at the base of riser instead of ell or bend. Steam separators and receivers act also as drip pockets. All these should be drained into the return system. The receiver between the cylinders of a cross compound engine receives condensate from the high pressure cylinder

and in addition considerable condensation takes place within it. All this water should be trapped to the return system. Sometimes it is necessary to drop a steam pipe around an obstruction. This forms a pocket which must be dripped. This sort of pocket is commonly found in the exhaust lines of steam engines. Failure to keep this pocket clear of water has wrecked many engines. In many plants an open drip is connected and the condensate wasted. It would be much better to trap the drip line and let the trap discharge into the hot well or open heater. If this is done a test valve should be installed between the exhaust pipe and the trap, and this valve should always be opened when stopping and starting.

Condensate from surface condensers should be delivered to hot well or open heater. While the temperature of this water may be much lower than that of the drips we have been considering, it is higher than that of any available water supply and in addition is pure water. Condensate from closed heaters is often wasted. It should be returned to the boiler.

Something has been said and more will be said about traps, and it may be well to take a moment to point out the essential differences in the types of traps. A steam trap is a device which operates automatically to allow the passage of water but prevent the passage of steam. It is a "So far and no farther" affair. The action may depend upon the filling of a bucket, the rise of a float, expansion, and various other things. Traps may differ in appearance as much as an ostrich and a jack-knife but they all do the same work. Their main fault is leaking steam, and when a trap begins to leak, it is a wasteful affair. Therefore, leaks should be watched for. In the trap discharge line close to the trap there should be a tee and valve as indicated in Fig. 6. Every trap should be given a number and a report sheet made up with space for recording the result of every test. Inspections of traps should be made daily by some competent person.

A return trap is really a direct contact steam pump. The trap has two positions. In one position the chamber is open to receive condensate. In the other that connection is closed and connection is made to steam at boiler pressure on one side and the boiler feed line on the other. The trap must be located above the water line of the boiler. It must be understood that this device *consumes* steam.

A vacuum trap resembles the steam trap, in that it is for the purpose of draining water from pipes and apparatus. In construction it resembles the return trap. Water collects in the trap under vacuum until there is enough to operate the mechanism. This closes the connection to vacuum and opens a vent. Ordinarily this vent is to the atmosphere. If it can be connected to low pressure steam, there will be some advantages.

Systems of Returns

In the ordinary residence steam heating system, the radiators are above the water line of the boiler and the condensate returns by gravity. There are some power plants where the same conditions hold and drips may be returned by gravity. This is the best and simplest method and should be used wherever possible. In many plants the drips from the steam header may be returned in this way. But in the majority of power plants other methods must be adopted for the return of other high pressure drips and of course no low pressure drips can be returned in this way. Where the drips are all high pressure but from some apparatus below the water line, the steam loop may be used. This is a well known and simple device. The Holly Return System is an elaboration of the steam loop and is more flexible. It can handle only high pressure drips and requires much head-room; but in places where it can be used, it is an excellent device. There are no working parts to get out of order and no valves to leak. It handles the drips without loss of pressure and the consequent loss of heat.

If head-room cannot be had, the receiver and pump may be used. Where all drips are high pressure, this may be operated on the closed circuit system. The receiver is located lower than the lowest drip and all drip lines are brought to it without traps, but with check valve in every line to prevent backing up. The pump, governed by a float in the receiver, returns the condensate direct to the boilers without loss of pressure.

Where, as is more usual, the drips are of various pressures, traps should be installed on the various drip lines and these traps should all discharge into the receiver. The receiver is vented to the atmosphere. In this method the high pressure drips are reduced in pressure and loss of heat occurs. If the plant is large, it may be advisable to have two systems—one for the high pressure drive, and one for the others. The make-up water may be fed to the boilers by a separate pump, or it may be introduced into the receiver and the mixture pumped through a closed heater.

A similar method consists of trapping all returns to an open heater, in which make-up water is added and heated.

Instead of the receiver and pump, a return trap may be used, provided it is possible to bring all drips to a point above the boiler. If this cannot be done, a second trap similar in design to the return trap must be used to elevate the drips to the required height.

When a single plant serves several buildings scattered over a considerable area, none of the foregoing systems will suffice for the collection of drips. Pockets in return lines are unavoidable. The pressure required in a distant building may be insufficient to force the drips back to the open heater. In such cases, a vacuum system will be found to be best. In this system, a small steam trap is located at every drip point and these traps discharge into a common return main which is led to a pump which maintains a partial vacuum. The vacuum pump should discharge into an open heater or hot-well. This system is deservedly gaining in favor and its use is not confined to large plants.

When condensate from closed heaters, exhaust heating coils, and other apparatus using exhaust is to be handled, the danger of getting cylinder oil into the boilers must be considered. If turbines are in use, this question will not have to be considered. But where reciprocating engines and pumps furnish the steam, precautions must be taken. Some steps in this direction are presented here.

1. Reduction of quantity of cylinder oil used. In very few plants is the quantity as low as it should be. In many cases it is from 200 per cent to 400 per cent of what is really required.

2. The use of graphite. There are now good feeders on the market and by using graphite the quantity of oil may be cut to a low figure.

3. The use of straight mineral cylinder oil. This may be done if the graphite is properly used.

4. Use of an oil separator in the exhaust line.

5. Filters: coke, sand, terry cloth, or combinations of these.

6. Chemical treatment. The writer's notebook reminds him of an installation which he saw some time ago, and which is shown in diagram in Fig. 7. In this plant practically all the exhaust steam was used in heating the mill and in heating water for mill processes. The drips from heating coils and open heater were carried to an open well and from there pumped to an elevated wooden tank with partitions as indicated. In

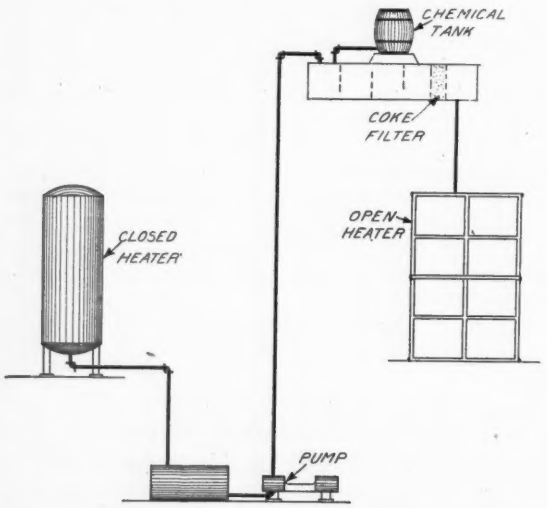


FIG. 7. ARRANGEMENT OF APPARATUS FOR CHEMICAL TREATMENT OF CONDENSATE

the first section of this tank a solution of ferric alum was introduced. This solution was made by dissolving 1½ lb. of the ferric alum in a barrel of water. This mixture made up a day's supply, treating about 40,000 lb. of exhaust condensate. It will be noticed that the condensate was treated before being mixed with make-up water. This is the proper method. The coke filter removed the precipitated oil. This filter was renewed once a month.

The drip from oil separators is usually thrown away; but this is a mistake. A good oil separator, properly installed, will remove about 90 per cent of the oil. There are patented devices on the market which will reclaim nearly all this oil. If it seems inadvisable to buy one, a very good home made article may be built cheaply. One such was made from a steel paint drum. A baffle plate was inserted as indicated by the dotted line, Fig. 8. The pipe from separator entered on one side of this baffle and the overflow pipe was connected on the other and near the bottom. This pipe was carried nearly to the top of the tank and the return bend was drilled to prevent siphon. The oil rose to the top and was skimmed off through pipe B by closing valve A.

Many engineers who complacently believe that all is well in their plants would meet with surprises if they would but make an inspection of the drip system under their charge. Such an inspection is the suggestion made here. One prerequisite of efficiency is that we must have records, another is that there must be plans, and neither gets us very far unless there is some action taken—dispatch. So when you inspect your drip system, make a record and make it complete. Trace along the steam pipes and see if there is any point where a drip should be added. If you find one record, put it in your notebook. At every drip point answer these questions:

1. What is total heating surface of apparatus drained?
2. What is the pressure in the apparatus?
3. What rate of heat transmission should be allowed?
4. Amount of condensate to be removed per hour? Estimated? Tested?

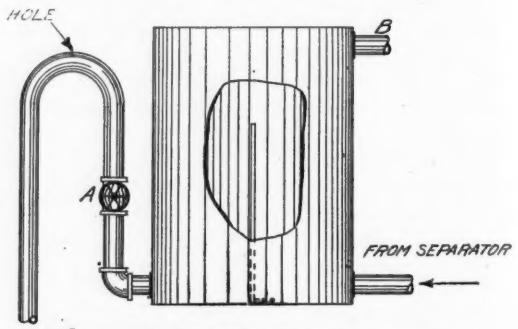


FIG. 8. DEVICE FOR RECLAIMING CYLINDER OIL

5. Is drip properly located?
6. Is it trapped?
7. Is trap needed?
8. Is trap too large? Too small? What is size?
9. Is trap of suitable type? Type? Maker?
10. Are return pipes covered?
11. Are return pipes of proper size?
12. Is trap leaking?
13. Is bypass open? Leaking?
14. Into what is trap discharge led?
15. Is this proper?
16. Is discharge pipe as direct as possible?

First get your records complete and in shape before you. Then criticise the plan. If the plan is right and carefully carried out, then the inspection should cause satisfaction. If the plan is wrong, plan a new plan. If the plan was not followed, if there are found to be mistakes, correct them.

It may assist somewhat if before making an inspection, one makes a list of mistakes that are commonly made and which it is desired to avoid. Below is given such a list which may be taken as suggestive.

1. Drip above engine throttle connected to sewer. The water which is wasted in this way may not be hot,

though some of it must be; but the water is distilled water and therefore free from scale forming material.

2. On starting up heaters, dryers, etc., it is common practice in many plants to open a bypass to the sewer until steam blows through, then let the trap do the work. It would be much better simply to bypass the trap into the return line and save the water.

3. Closed heater dripped to sewer. In many plants the demand for hot water for processes is so great that all the engine exhaust is condensed in the heater. The possibilities of saving from putting this water back into the boilers are considerable. If the closed heater can be located above the receiver or open heater, this will be found to be the best arrangement. If it must be set up on the same or lower level, then a pump may be installed to lift the drip, as suggested in Fig. 7.

4. Wasting of drip from receivers of compound engines.

5. Open heater overflowing to sewer. The storage capacity of the open heater is usually small. The float actuated make-up valve keeps the water level at the highest point, and when a slug of drip water is returned,

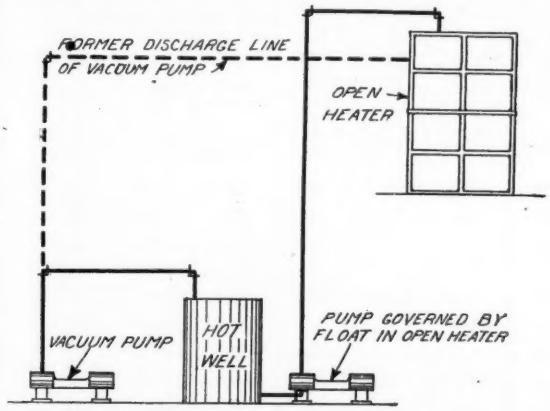


FIG. 9. METHOD OF SAVING OVERFLOW FROM HEATER

the overflow gets busy at once. In one plant where drips were collected by a vacuum pump, it was found that an amount equal to 12 per cent of the total feed water was being wasted in this way. The vacuum pump discharge was taken from the heater and put into a hot well, from where it was lifted to the heater by a new pump which was governed from the float in the heater. The make up water was introduced into the hot-well. Figure 9 shows the changed arrangement. The feed water temperature was increased 30 deg.

6. Wrong return system. Trapping high pressure drips to open heater or receiver when they could be returned direct to boilers is one common error. Others are suggested above.

7. Use of a "cracked" valve instead of a trap.

8. Trap discharging into sewer or river.

AS A PACKING for shafts of propellers for agitating brine in ice tanks, J. E. Aue advises the use of rawhide belt lacing, braided and rolled around the shaft. Set it up lightly with the gland and it gives little friction and long life.

Save for the Wounded

A LARGE percentage of the money which will be subscribed to the Fifth Liberty Loan will go toward the rehabilitation of wounded men. The United States Government is resolved to do its utmost to restore every wounded American soldier and sailor to health, strength and self-supporting activity. He will not be discharged from the hospital until all the medical and surgical treatment necessary to restore him to health has been given him, under the jurisdiction of military or naval authorities, according to the branch of service he is in.

Then his future will be considered by the Federal Board for Vocational Education. If he has been disabled in such a way that he cannot take up the work he left to go into the country's service, a large vocational field is opened to him, with a wide choice of occupations. He is carefully trained to self-supporting activity.

If he needs an artificial limb or mechanical appliance, the Government will supply it free, keep it in repair and renew it when necessary. If, after his discharge from the hospital, he again needs medical treatment on account of his disability, the Government will supply it free. While he is in the hospital and while in training afterwards, the soldier or sailor will receive compensation as if in service and his family or dependents will receive their allotments.

Also, a wounded soldier or sailor, regardless of whether his disability prevents him from taking up his former employment, may take a course in vocational training, free of cost, and the war-risk insurance compensation will be paid him during the time of training. In this case, no allotment will be paid to his family.

The training branches, with their thousands of trained instructors, will use millions of the nation's dollars, and the country, instead of being filled with dependent cripples and beggars, will have thousands of highly trained men—heroes, the glory of whose sacrifice will not have been tarnished.

That's one of the reasons why the Fifth Liberty Loan must be fully subscribed. The first three loans launched America in the war, built training camps and equipped and sent men overseas. The Fourth Liberty Loan, the "fighting" loan, backed up the fighting men and made overwhelming victory for the Allies possible. The Fifth or Victory Loan will be just as important in the annals of war loans, for both moral and material reasons. America would be monstrously ungrateful should she not stay with her men in khaki and blue until they are returned to their homes, physically strong and able to earn a livelihood. The best way for every person to show his personal gratitude is to start now planning how much he can subscribe to the Fifth Loan.

MORE THAN $3,000,000 worth of improvements are under way at the Charlestown navy yard. Building 42, the machine shop, is to have $750,000 expended on it in changes. The changes at the power house are to cost $450,000; the extension of the pier is to cost $100,000 and the extension of the shipfitters' shop, $500,000.

Fuel Economy in Hand-Fired Power Plants---V*

Steam Piping Requirements; Records of Operation

IN ORDER to promote the economical use of coal, the steam generated should be transmitted to the point of use with as little loss of both heat and steam as practicable. This means that the piping system should be as simple as possible and well insulated, and only short direct runs should be used in connecting boilers, engines and other apparatus.

All branch lines not in use should have the valves closed so that steam cannot enter them and waste heat by condensing in these dead ends, and the stop valves should be located so as to accomplish this purpose. If the engine is shut down for any length of time the valves at both ends of the engine lead should be closed to prevent steam from condensing in and filling up this lead.

Each high pressure header and steam separator should be dripped and the hot water returned to the feed-water heater, which should be included in the equipment of every power plant since each 11 deg. F. increase in the feed-water temperature will effect a saving of nearly one per cent in the coal burned. In no case should cold water be fed direct to the boilers, even if live steam has to be used for heating it.

The oily drips from the exhaust steam header should be discharged to the sewer or wasted, since the oil they carry has an injurious effect upon the boiler tubes and shell, and may do much more harm than the fuel value of the heat contained in these drips is worth.

The boiler blowoff cock or valve must be perfectly tight to prevent the escape of any hot water to the sewer or other waste channel. If the end of this line cannot be readily inspected to make sure that all blowoff valves are tight, then a tell-tale connection with valve should be placed in the blowoff line beyond the main cock so that by opening it a leak at the blowoff will at once be apparent.

Leaks of hot water or steam which appear in any line either at a valve, flange, or other fitting should be stopped immediately; otherwise a serious waste of fuel may result in making up the heat so lost. An even more serious condition may result if a leak is so located that it discharges water and steam over any part of the boiler or over another pipe since corrosion is very rapid in such a case. In fact, such leaks have started corrosion which later resulted in boiler explosions.

COAL AND STEAM LOSS BASED ON 100 FT. OF UNCOVERED STEEL PIPE

Steam at Gage Pressures of 50, 100, 150, and 200 pounds per square inch. Air Temperature 70 degrees F., feed temperature = 200 degrees F.
Heating value of coal = 12,000 B. t. u. per pound. Boiler and furnace efficiency = 60 per cent.
Coal at $5.00 per ton. Time = 24 hours per day and 365 days per year.
Note.—A good pipe covering will save 75 per cent to 85 per cent of this loss.

		Pressure = 50 Lb.			Pressure = 100 Lb.			Pressure = 150 Lb.			Pressure = 200 Lb.		
Pipe Size	Surface per 100 Lineal Feet	Steam Condensed per Hour	Coal per Year	Coal Cost per Year	Steam Condensed per Hour	Coal per Year	Coal Cost per Year	Steam Condensed per Hour	Coal per Year	Coal Cost per Year	Steam Condensed per Hour	Coal per Year	Coal Cost per Year
Inches	Square Feet	Pounds	Tons	Dollars	Pounds	Tons	Dollars	Pounds	Tons	Dollars	Pounds	Tons	Dollars
1	34.5	24.3	16 2	81	32.0	20.6	103	38.6	24.1	121	43.8	26.7	134
1¼	43.5	30.6	20.1	101	40.4	25.8	129	48.8	30.7	154	55.3	33.7	169
1½	49.8	35.1	23.2	116	46.2	29.3	147	55.8	35.0	175	63.3	38.5	193
2	62.2	43.8	28.9	145	57.6	36.8	184	69.7	43.4	217	79.1	48.6	243
2½	75.3	53.0	35 0	175	69.8	44.7	224	84.4	52.6	263	95.7	58.7	294
3	91.6	64.5	42.5	213	84.9	54.3	272	102.7	63.9	320	116.4	71.4	357
3½	104.7	73.7	48.6	243	97.0	61.8	309	117.4	73.1	366	133.1	81.5	408
4	117.9	83.0	54 8	274	109.3	69.6	348	132.2	82.3	412	149.9	91.5	458
4½	131.0	92.2	60.4	302	121.4	77.5	388	146.9	91.5	458	166.5	102.1	511
5	145.6	102.5	67.5	338	134.9	86.3	432	163.2	101.6	508	185.1	113.4	567
6	173.6	122.2	80.6	403	160.9	102.9	515	194.6	121.3	607	220.6	134.9	675
7	199.8	140.6	92 4	462	185.2	118.3	592	224 0	139.7	699	253.9	155.5	778
8	226.0	159.1	104.7	524	209.4	133.6	668	253.4	158.1	791	287.2	175.6	878
9	252.3	177 6	116.9	585	233.8	149.4	747	282.9	176.5	883	320.7	196.2	981
10	281.0	197.8	130.1	651	260.4	166 4	832	315.1	196.7	984	357.2	218.6	1093
11	307.8	216.6	142.4	712	285.3	182.2	911	345.1	215.5	1078	391.2	239.2	1198
12	334.0	235.1	154.6	773	309.5	197.5	988	374.5	233.9	1070	424.5	259.7	1299

Size of Steam and Exhaust Mains

THE SIZE and length of steam and exhaust mains may adversely affect the fuel consumption of a plant if these lines are either (1) too small, or (2) too large

* Abstract of Circular No. 7 Entitled Fuel Economy in the Operation of Hand Fired Power Plants, Published by the University of Illinois Engineering Experiment Station.

for the proper handling of the steam they have to carry.

If the steam main between boiler and engine is too small or too long, it will be necessary to carry a much higher pressure at the boiler than would otherwise be necessary in order to get the required pressure at the engine. The excessive friction in small steam lines causes this loss in pressure, and if the main is also very long the loss will be still more pronounced. Steam gages at the boiler and at the engine throttle should not show a difference, or a drop in pressure of more than 5 lb. when the engine is running at full capacity. Should it be necessary to carry a much higher pressure at the boiler than at the engine in order to get a satisfactory operating pressure, some unnecessary coal must be burned since all the heat losses will be slightly increased and

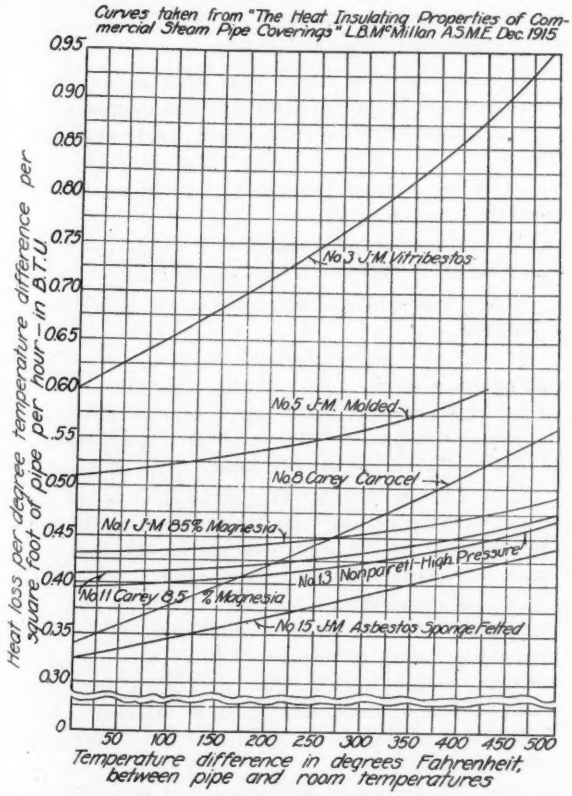


FIG. 1. AMOUNT OF HEAT TRANSMITTED BY STEAM PIPES INSULATED WITH COMMERCIAL COVERINGS

leaks will be somewhat more likely to develop.

On the other hand, if this main is too large the pressure at the engine throttle will be almost the same as that at the boiler when running at full capacity. The heat losses from oversize pipes and fittings are greater and the first cost of installation is higher than for mains of the proper size.

In the case of the exhaust main, the size is most important since the steam has now expanded and occupies a much greater volume than when it left the boiler. This exhaust steam must be discharged from the engine at the lowest possible back pressure if the engine is to get the most work out of each pound of steam supplied to it and hence develop the greatest power. With exhaust piping which is too small, a steam gage on the line will show a back pressure of more than 2 lb. which means that more steam is being taken into the engine to do the work than is necessary. Exhaust mains are almost never too large, but in such cases the excess heat loss due to radiation from large exhaust mains is not so serious as in the case of high pressure steam mains since the temperature of exhaust steam is much less than that of live steam.

Heat Insulating Materials Required

Desirability of covering or insulating all high temperature surfaces around a boiler and power plant is self-evident. It can be shown that by covering all steam and hot-water pipes, fittings, flanges and valves enough heat can be saved as compared with the loss from bare pipe to pay for the labor and covering material in a

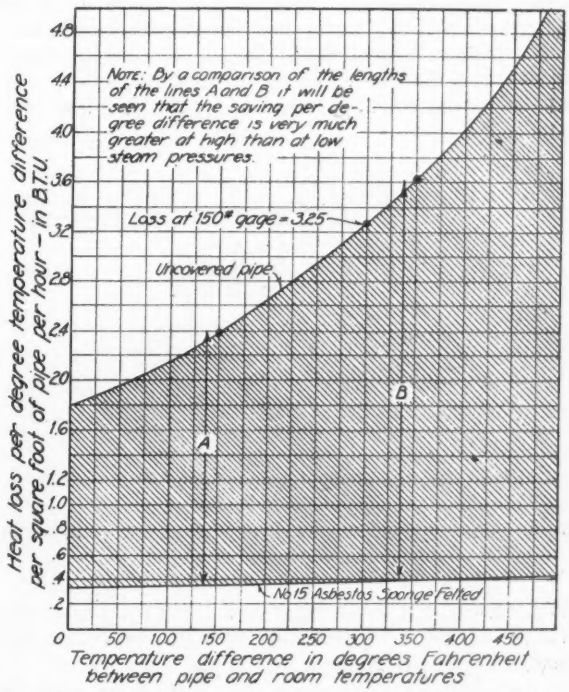

Heat loss per degree temperature difference per square foot of pipe per hour — in B.T.U.
Note: By a comparison of the lengths of the lines A and B it will be seen that the saving per degree difference is very much greater at high than at low steam pressures.
Loss at 150# gage = 325
Uncovered pipe
A
B
No.15 Asbestos Sponge Felted
4.8
4.4
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
1.0
.8
.6
.4
.2
0
50 100 150 200 250 300 350 400 450
Temperature difference in degrees Fahrenheit between pipe and room temperatures

FIG. 2. HEAT LOST BY BARE STEAM PIPE AND SAVING WHICH MAY BE SECURED BY THE USE OF GOOD COVERING

very few months. This, of course, applies to the ordinary commercial coverings ranging from 1 to 2 in. in thickness. The table shows the saving per year for 100 ft. of covered pipe in pounds of coal and in dollars with coal at $5 a ton (2000 lb.).

The best commercial coverings 1 in. in thickness will save or prevent the escape of from 75 per cent to 85 per cent of the heat lost from bare pipes. The thickness of the covering should be varied with the temperature of the steam or water in the pipe line, but in general it will pay to use not less than 1 in. on all lines which are at 200 deg. F. and up to 300 deg. F. Above 300 deg. F. and up to 400 deg. F. it is advisable to use 1½-in. covering and above 400 deg. F., not less than 2-in.

The actual heat saving value of commercial pipe coverings now on the market has been the subject of

many investigations. The latest work in this field has been done by L. B. McMillan at the University of Wisconsin and the charts (Figs. 1 and 2) have been made from the results of his tests on bare and covered 5-in. steel pipe. These charts show how the heat transmitted by bare pipe compares with the heat transmitted by the same pipe when insulated. The values of only seven of the 20 or more coverings tested are shown. Their efficiency as insulators is easily seen by reading the scale at the left of the chart, which shows the heat lost or transmitted per hour per square foot of pipe surface per degree difference of temperature between the steam in the pipe and the air outside. The heat loss is expressed in B.t.u.

The importance of covering steam lines operating at high pressures and temperatures is emphasized by Fig. 2. It will be seen by reference to the upper curve in this diagram that the heat loss per square foot from an uncovered 5-in. steam line increases very rapidly as the temperature of the steam in the line increases. By covering the line with a good insulator, not only is a large saving effected by reducing the heat loss (see

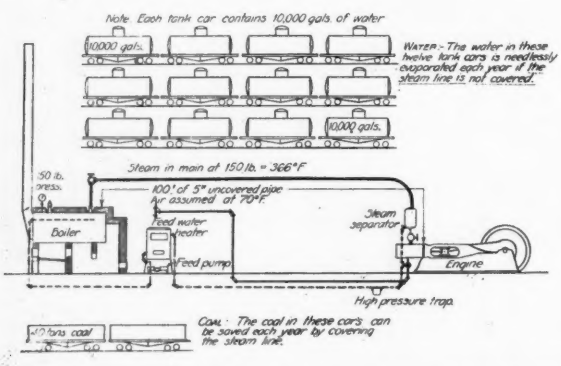

Note. Each tank car contains 10,000 gals. of water
10000 gals.
Water:- The water in these twelve tank cars is needlessly evaporated each year if the steam line is not covered.
10,000 gals.
Steam in main at 150 lb. = 366°F
50 lb. press.
100' of 5" uncovered pipe
Air assumed at 70°F.
Boiler
Feed water heater
Feed pump
Steam separator
Engine
High pressure trap
40 tons coal
Coal: The coal in these cars can be saved each year by covering the steam line.

FIG. 3. COMPARATIVE WATER AND STEAM SAVING EFFECTED BY COVERING LIVE STEAM MAIN

shaded area), but the *increase* in the heat loss per square foot from such a covered line at high temperatures is very much less than for a bare pipe.

The chart (Fig. 2) shows that with steam which is 300 deg. F. above the temperature of the outside air a 5-in. diameter standard bare steel pipe transmits about 3.3 B.t.u. per square foot per hour, while the same pipe covered with "Nonpareil High Pressure Covering" transmits only 0.425 B.t.u per hour or 13 per cent of the heat wasted by the bare pipe. In other words, about seven-eighths of the loss has been stopped by the covering.

Requirements for Good Covering

A satisfactory pipe covering must be, (1) unaffected by heat or fire, (2) easily molded and light in weight, (3) impervious to or unaffected by water and steam. (4) non-corrosive in its effect upon metals (steel, iron and brass), (5) structurally fairly strong or self-sustaining and (6) sanitary and not attractive to vermin of any kind.

Uncovered Pipes Waste Steam

The owner of a power plant should realize that an uncovered steam main wastes heat and that it should therefore be covered. The loss of heat means a loss of steam by condensation and the generation of steam by the boiler plant which cannot be used.

That this loss is serious and that it requires the boilers, the feed pumps and the traps to handle much more water than would be necessary if the steam mains were properly covered is shown by Fig. 3. The simple computations necessary to prove this statement for a typical case are given below. The plant shown in Fig 3 is operating 24 hr. per day for 365 days per year. A 5-in. steam main, which is uncovered, carries steam at 150 lb. gage pressure to an engine 100 ft. away. The air around the main averages 70 deg. F. and the feed water enters the boiler at 200 deg. F.

(1) Actual tests show that each square foot of pipe loses 3.25 B.t.u. per hour for each degree of difference in temperature between steam inside and air outside.

(2) The outside surface of 100 ft. of 5-in. pipe amounts to 145.6 sq. ft.

(3) The total heat loss from the pipe per hour is: $3.25 \times 145.6 \times (366 - 70) = 140{,}000$ B.t.u.

(The temperature of saturated steam at 150-lb. gage is 366 deg. F.)

(4) This heat is obtained *by condensing,* not by cooling some of the steam in the pipe. One pound of steam gives up 858 B.t.u. when it condenses at 150 lb. gage pressure, or the uncovered pipe condenses $140{,}000 \div 858 = 163$ lb. per hour.

(5) In one yeear, $163 \times 24 \times 365 = 1{,}428{,}00$ lb. of steam wasted; that is, this much steam *never reaches the engine.* At 8 1-3 lb. per gallon, 171,200 gal. of water have been needlessly handled.

(6) Expressed in another way, this plant has evaporated and sent over 17 tank cars (of 10,000 gal. capacity per car) of water into this line which did not perform useful work. This represents an absolute waste of coal, of steam and of boiler capacity. At least 75 per cent of this waste could have been prevented by covering the line.

(7) To evaporate each pound of this water from feed water at 200 deg. F. took 168 plus 858, or 1026 B.t.u., or a total of 1026×163, or 167,300 B.t.u. per hour.

(8) At 60 per cent efficiency each pound of coal (heat value taken as 12,000 B.t.u per pound) gives to the boiler 7200 B.t.u or the plant is wasting 23.2 lb. of coal per hour tc supply the condensation loss.

(9) The coal required per year is:

$23.2 \times 24 \times 365 = 203{,}000$ lb. or 101.5 tons.

(10) This means that this plant has to burn about 2½ cars of coal (holding 40 tons each) in order to provide for this annual heat loss. A good covering would stop 75 per cent of this waste and save two whole cars or 80 tons of coal a year. Bare steam pipe is a very expensive luxury in any power plant.

Purpose of the Record of Operation

The maintenance of such records of operation as may be necessary to enable the superintendent or owner of a plant to determine with reasonable reliability the cost of operation, the relative efficiency of the plant, and the improvement from time to time is essential. For practical purposes, the index to the performance of any steam generating plant lies in the relation between the number of pounds of water evaporated, and the number of pounds of coal fired less the weight of the ash. The record must therefore give the information on the basis of which this relation may be determined at any time, and it should also contain such other data as may be required for detecting and remedying any defects in operation which indicate loss.

(5) A draft gage connected into the space above the fuel bed and into the ashpit.

(6) A differential draft gage connected into the space above the fuel bed and into the flue gas passage near the point of discharge from the boiler.

(7) A CO_2 analyzer.

(8) A pressure gage at the boiler (pressure gages should also be supplied at the ends of all live steam lines).

(9) A pyrometer for indicating the temperature of the flue gases leaving the setting.

Some of these devices are already part of the equipment of most plants and the others may be secured at so slight a cost in proportion to the saving to be effected as easily to warrant their installation.

NAME OF FIRM

DAILY RECORD OF POWER PLANT OPERATION

Date.....

Boiler No.....

1st shift .....M to.....M.
Name of Fireman.....
2nd shift .....M to.....M.
Name of Fireman.....
3rd shift.....M to.....M.
Name of Fireman.....

	1st Shift	2nd Shift	3rd Shift
1. No. lb. Coal Fired			
2. No. lb. Ash Removed			
3. No. lb. Water Evaporated			
4. Temp. of Feed Water			
5. Boiler Pressure			
6. Draft Gage Readings			
7. Differential Gage Readings			
8. CO_2 Readings			
9. Temperature of Flue Gases			

FIG. 4. DAILY RECORD OF OPERATION

Character of the Record

It must be recognized that no satisfactory record of operation is possible unless the plant is equipped with certain checking and recording devices which have been recommended in the preceding pages of this discussion. These may be recounted as follows:

(1) Means of weighing the coal fired for each boiler.

(2) Means of weighing the ash removed from the pit.

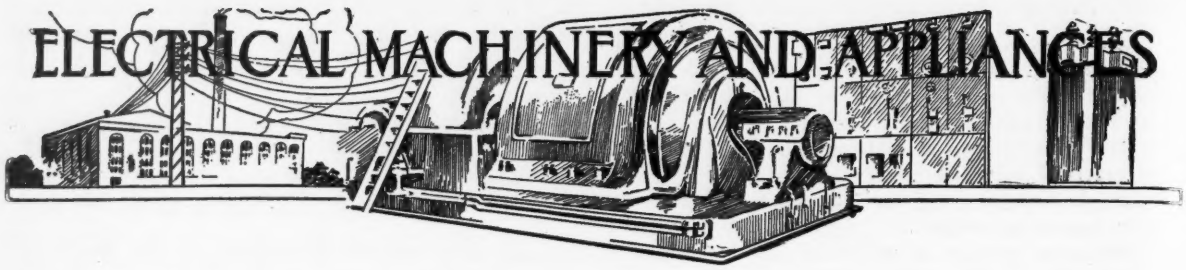
(3) Some device for weighing or measuring the water fed to the boiler or the steam delivered by the boiler.

(4) A thermometer for indicating the temperature of the feed water.

The daily record of operation should include the items shown in the form given herewith.

Items 1, 2 and 3 of this record should cover the entire shift of the firemen for each boiler. Items 4 to 9, inclusive, should contain readings taken for each boiler at regular intervals (the suggested form provides for hourly readings) throughout the shift as frequently as may be practicable. The choice of the individual to be charged with the responsibility of maintaining this record is a matter which will depend largely upon the character and size of the existing organization of each plant. In some cases it may be found satisfactory to entrust the matter to the fireman; in others it may be desirable to assign it to some other employe. It should be recognized that reasonable accuracy is essential.

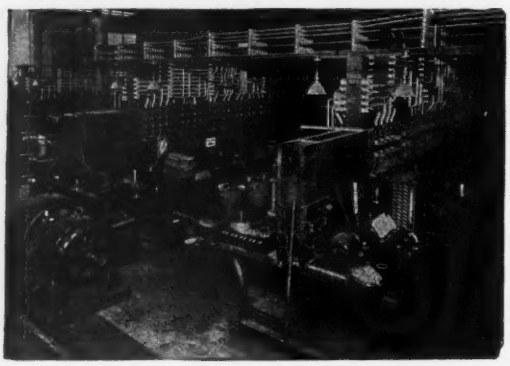
ELECTRICAL MACHINERY AND APPLIANCES



New Westinghouse Research Building

HIGH grade experimental work cannot be carried on in the midst of the noise and confusion of production. Quiet is the first essential for great achievement in research where uninterrupted concentration is required. Delicate instruments and the costly mechanism of an experimental laboratory must be protected from the dust and vibration of the shops.

The Westinghouse Electric & Manufacturing Co.'s New Research Building at East Pittsburgh, Pa., is located about a mile from the works on the Lincoln Highway. Architecturally, the building is plain but substantial, of reinforced concrete and brick, trimmed with white terra cotta. The distinctive features of the building are its plumbing and wire services being arranged in such a way as to enable these services to be brought into any particular laboratory when needed without disturbing any other part of the building.



RESEARCH FACILITIES DEVOTED TO ELECTRICAL PHENOMENA

Provision is made in the new building to deal with a large variety of experiments in many lines of work, including magnetic insulation, metallographic metallurgy, chemistry—organic and inorganic—furnace combustion, woodworking, illumination, glass blowing, etc.

While this new laboratory has been occupied for only a comparatively short time, the work already accomplished gives much promise for the future. The history of the Westinghouse research organization is interesting. This division was founded in 1906 as one of the several divisions of the Engineering Department. It is now divided into seven laboratories. The extent of work covered by the whole division is broader than is ordinarily included as research work. For example, it has charge of the preparation of all specifications for the purchase of materials used by the company, together with the experimental and development work leading up to these specifications. It includes a process section, which has electrical control of all the various processes used by the company in the manufacture of its product. It has charge of the routine chemical and physical testing for all departments, including the Inspection Department. It has technical control of the various metallurgical processes, such as those involved in the brass foundry, copper mill, scrap recovery plant, etc. Through the activity of its members on various standards and other committee work, it comes into contact with numerous activities not strictly of research nature, both within and without the organization.

Proposed Hydro-Electric Installation at Queenston, Canada

SPECIFICATIONS CALL FOR SPECIALLY DESIGNED UNITS TO BE AS SELF-CONTAINED AS POSSIBLE

SPECIFICATIONS have been issued by the Hydro-Electric Power Commission of Ontario for generators for the initial installation of probably 200,000 hp. at Queenston. According to the Canadian Engineer, each generator will have a capacity of 45,000 kv.a. at 80 per cent power factor.

It is proposed that each generator be completely enclosed and the cooling be effected by air, either forced in or exhausted by suitable fans. The intention is to draw the air from a gorge located on the east of the station at a height above the flood level and supply it direct to the generators through ducts, either at the bottom, or the bottom and the top, discharging at the rear of the station near the roof.

If possible, the generators are to be self-ventilating by means of suitable fans mounted on the rotor, making the generators as self-contained as possible. According to specifications, the temperature rise of the generators must not exceed 100 deg. C., with cooling air at 40 deg. C., if mica and cambric insulation is used, and if other class of insulation is used, the temperature rise will be considered as recommended by the manufacturers; provided it does not exceed at any part of the units 90 deg. C. by thermometer or 110 deg. C. by embedded temperature recorders, of which at least 24 will be installed at various parts of each unit.

Each unit will have a vertical shaft, revolving field with thrust bearings and, if possible, direct connected exciter, and will be capable of delivering mechanically

the rated capacity of its water turbine, approximately 52,500 hp., and be capable of safely carrying momentary overloads to which it may be subjected.

Each unit will operate at a normal speed of 187.5 r.p.m., frequency 25 cycles, and must be designed to operate continuously, with no load, but with normal field current, at 347 r.p.m. without injury in any respect. The normal voltage to be generated is 12,000, but the design must safely permit a potential rise to 13,200 volts for several hours.

A brake device is required for stopping the rotor after water has been shut off, consisting of a number of brake cylinders and plungers secured directly to the foundation, with the plungers bearing on a surface forming part of the rotor and capable of bringing the rotor to rest from normal speed within 5 min.

The armatures must stand a ground test of 30,000 volts for one minute duration, which potential test also applies between phases of the windings, and the field windings a potential of ten times the rated exciter voltage. Wherever possible, the insulation of conductors and supports will be covered with fireproof material.

It is not likely that the initial installation will comprise more than four of these units; it is, however, intended to make additions from time to time as the power demand increases, with a possibility of reaching a million hp.

Changing Speed of Induction Motors

Possible Speed Changes of Induction Motors to Suit Conditions in Power Plants

IN the November 15, 1918, issue we discussed the possible speed changes of induction motors by changing the number of poles and regrouping the coils in the motor. A motor having 48 slots, 48 coils was considered in the article. A motor having 72 shots, 72 coils will be considered in this article with a frequency of 60 cycles.

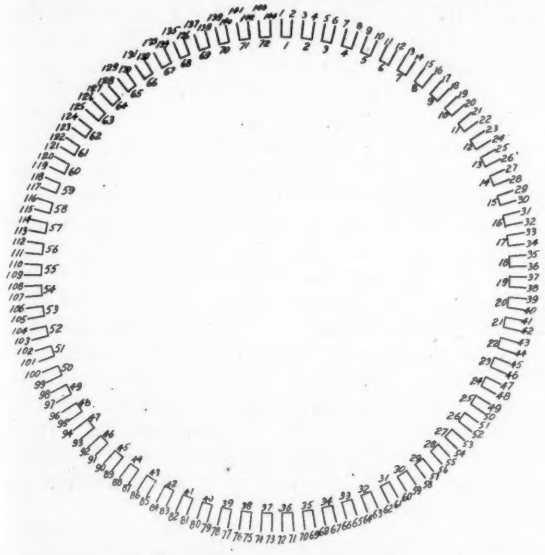


FIG. 1. SHOWING 72 COILS IN STATOR WINDING. EACH COIL HAS 2 LEADS NUMBERED FOR FORMING CONNECTIONS FOR DIFFERENT NUMBER OF POLES

The following table shows possible speed changes of a 3 phase 60 cycle induction motor having 72 coils and necessary connections:

No. of Poles	Speed r.p.m.	Coils per pole per phase
2	3600	12
4	1800	6
8	900	3
12	600	2
16	450	mixed 24-2
		24-1
18	400	mixed 18-2
		36-1
24	300	1

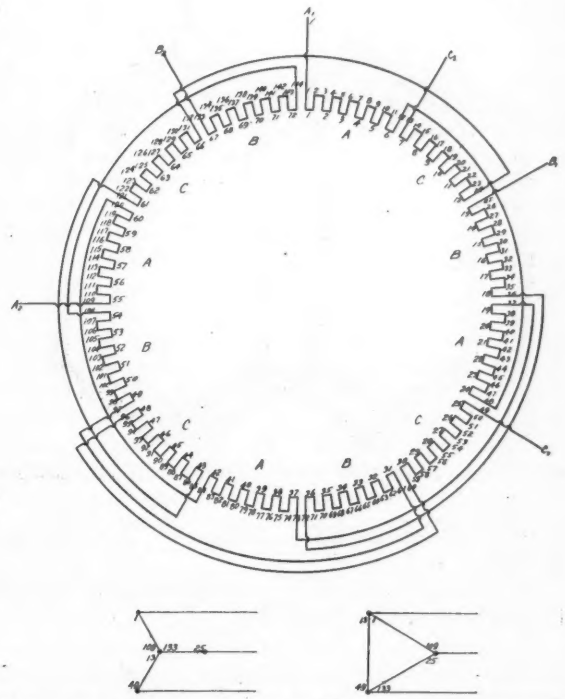


FIG 2. CONNECTIONS FOR 4 POLE 72 COIL STATOR WINDING

2 Poles 3600 R.p.m.
2 to 23 inclusive in series
26 to 47 " " "
50 to 71 " " "
74 to 95 " " "
98 to 119 " " "
122 to 143 " " "
24 and 96 in series
72 and 144 " "
120 and 48 " "

For Y connection: 1-49-97 line.
73-120-25 forms star connection.
For delta connection: 49 and 73 line. 97 and 120 line. 1 and 25 lines.

4 Poles 1800 R.p.m.
2 to 11 inclusive in series
14 to 23 " " "
26 to 35 " " "
38 to 47 " " "
50 to 59 " " "
62 to 71 " " "

74 to 83 inclusive in series
86 to 95 " " "
98 to 107 " " "
110 to 119 " " "
122 to 131 " " "
134 to 143 " " "
12, 48, 37, 73, 84, 120 in series
36, 72, 61, 97, 108, 144 " "
60, 96, 85, 121, 132, 24 " "
For Y connection: 1, 25, 49 line.
109, 133, 13 forms star connection.

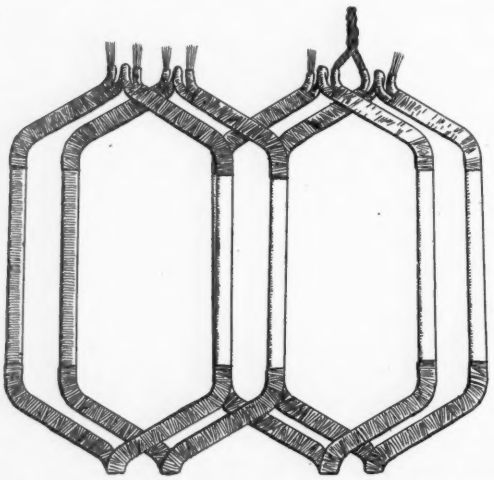


FIG. 3. SHOWING TWO LEADS TO EACH COIL AND METHOD OF CONNECTING GROUPS

For delta connection: 25 and 109 line. 133 and 49 line. 1 and 13 line.

For 8, 12, 16, 18, and 24 poles the groups are reduced in proportion as shown in table.

THE FIRST definite steps looking toward the ultimate electrification of all the lines of the Southern Pacific Co. were taken by engineers for the company recently, when plans for great development of power in the Pitt river were outlined. Already, it is announced, two dam sites, capable of impounding many millions of gallons of water for the power project have been selected. One of these sites is about 3 mi. up steam from Copper City and the other is 12 mi. farther along.

While these are the only two definitely decided on at this date, it was said that other dams on railroad land farther up the river are also to be constructed, in this way using the water for power purposes over and over again.

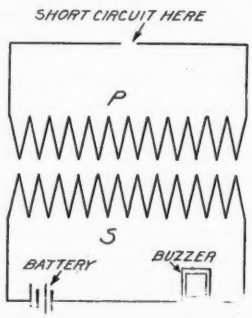
Railroad men state that this is the initial step in the plan of the railroad to electrize its entire system, intrastate as well as transcontinental, and with the war safely out of the way, the work will be rushed to speedy completion. Details of the plan for the electrization of the system were published a short time ago exclusively in The Bulletin.

SOMEBODY asks whether success is most due to luck, pluck or brains. The answer is easy—all three.

Simple Test for Lighting Transformers

SOMETIMES transformers become defective, especially those subject to heavy overloads and others by being damaged by lightning discharge, and give more or less trouble. When a transformer commences to give trouble, a simple test to determine its extent of damage can be made with a buzzer and one or two dry batteries as follows:

Connect secondary side of transformer in series with buzzer and battery as shown in the illustration. Short-circuit the primary lead by taking hold of the two wires and bringing them together at the ends. If the transformer has short circuited coils, the sound of the buzzer will decrease slightly. If the transformer secondary or primary winding is completely burned out, the buzzer will have the same pitch as when connected direct in series with the batteries. If the transformer is in good condition, the buzzer sound will increase.



CONNECTIONS FOR TESTING LIGHTING TRANSFORMER

A 55,000-KW. Turbo Alternator

THE FIRST turbo-alternator of 60,000 kv.a. capacity has recently been completed in the A. E. G. (German) works, and the following description is abstracted from Elektrotechnische Zeitschrift. The output of the machine is 55,000 kw., at a speed of 1000 r.p.m. It gives 7000 volts, three-phase, with excitation at 220 volts. The turbines work at a super-heat of 326 deg. C., and with cooling water at 27 deg. The weight of the turbine is 250 tons, of which the turbine rotor is responsible for 49 tons; the total weight of the alternator is 225 tons and of its rotor 106 tons. The entire weight of the machine, turbine and alternator, is thus 475 tons.

This machine, together with a second one of similar size and output, designed by B. Goldenburg, will be installed in the Rheinisch-Westfalische Elektricitatswerke power station, located on the site of the coal fields at the foot of the hills near Cologne. The total installation at this station (named after the designer, the "Goldenburg works") will consist ultimately of six turbo-alternators from 15,000 kw. each up to about 200,000 kw.—ELECTRICAL EXPERIMENTER.

THE HARTLAND (W. VA.) POWER CO. is extending its Elk River transmission system so as to furnish electricity for three more coal mining companies.

Experiences at the Glendale Plant

THE FINAL NARRATION OF ENGINEER WALLACE. BY G. H. KIMBALL

AFFAIRS in the station were very quiet as the engineer sat gazing thoughtfully at the circulating pump while Richards, the oiler, who had an unusual thirst for knowledge, was poring over the pages of a power plant magazine. Suddenly he looked up and asked:

"What's an internal combustion engine?"

"One that burns its fuel directly in the cylinder," said Wallace, then adding, "the fuel must be gaseous or liquid and must not contain anything that will leave a deposit in the cylinder."

"Then auto engines are of that type," said the oiler.

Wallace nodded as he said, "also any gas, gasoline or oil engine."

Hall, the electrician, had just joined them and he reminded Wallace of his promise to tell them some of his experiences with oil engines at the Glendale power station.

"The first time I ever heard them mentioned was during the first year of my work at Glendale, when Phillips, the manager, told me of a street railway company having a power station that was delivering current for the small sum of six mills per kilowatt at the switchboard. This figure, he added, the oil engine people guaranteed to cut in two. Later he spoke of visiting the shop where they were made and making some inquiries about them. If it developed as it then promised he proposed to install them and in that case he would try to get all of the power business in that vicinity."

"What did you think of the proposition?" asked the oiler.

"Being a steam man, naturally I was not very enthusiastic," the engineer replied; "however, plans were soon made to form a company to develop another water power site and the idea was to install 1000 hp. of oil engines in our station to help out in dry weather. Soon after that, preparations were made to install the first engine and after many days it was done and when she turned over it was quite a surprise to many who thought that they would not prove successful."

"Did you feel confident of handling them?" asked Richards.

"Not very," was the reply, "but the erecting engineer stayed with us for some time and every day we became more familiar with the operation of the machine."

"It must have seemed queer to operate after steam engines," said the oiler.

"It was indeed," replied the engineer, "for it had six cylinders as a whole and it was really made up of two three-cylinder engines with separate governors and these coupled to the short shaft with the flywheel and rotor on it. The whole unit was 39 ft. long and the engine alone weighed 100 tons."

"What was the speed?" asked Hall.

"She turned at 164 revolutions," replied the engineer.

"Why was she so heavy?" asked Richards.

"Because of the extremely high pressures carried; and to make it clear to you, it is necessary to explain something about the way in which this type of engine was developed.

"There are several types of oil engines, but the most prominent one is the Diesel, which was first brought to the attention of the mechanical world by Dr. Diesel, who was a scientist at Munich, Germany. His early experiments were performed on crude one cylinder motors and he constructed three of them before he could get one that would run, but with the first he had a demonstration of the principle that makes his engine today most prominent."

"What was that?" asked Richards.

"After turning the first motor over, he injected a charge of oil and there was an explosion which blew off the indicator."

"That came from the spark, I suppose," put in Hall the electrician.

"No," answered Wallace, "for the inventor's idea was to ignite the oil by the heat of the air which he had compressed in the cylinder and when the explosion took place, he knew that such an event was possible. Thus this form of oil engine was built on that principle and in that feature it is far ahead of any gas or gasoline engine both in economy and reliability."

"They must have made many improvements on them since," said the oiler.

"Oh yes, very many; for such a unit must be reliable if you wish to furnish power to customers with it."

"Tell us something of the principle of burning the oil," said Richards.

"You are doubtless aware of the way that gasoline is consumed in an engine by being converted to a gas in the carburetor and then after being compressed with the proper mixture of air in the cylinder, it is exploded by the spark. The only thing in the oil engine that resembles that is the first downward stroke during which the cylinder is drawn full of pure air. This is compressed to about 500 lb. per square inch which heats it to about 1000 deg. F.

"The fuel which is a low priced oil is then injected in the form of spray and the heat ignites it, not as an explosion, for it is not in gaseous form but a very quick burning takes place which furnishes the power to the piston."

"How did they work?" asked Richards.

"Very well," answered Wallace, "after we had become more familiar with the principles of operation. The valve setting on them is very simple, for the valves move but half as many times as there are revolutions on account of the four-stroke cycle."

"What is that?" asked the oiler.

Wallace replied as follows: "Every engine piston is said to go through a cycle in order to produce a power stroke, and some take two strokes to do it, while others

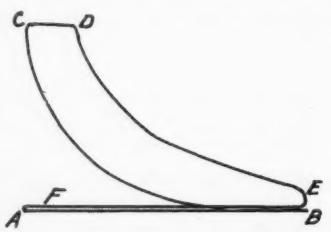
need four, as these engines did. Therefore the valves do not function for every stroke so that the cam shaft needs to turn but half the speed of the crank shaft. There are three valves, an exhaust, an air admission and a fuel valve, and the first two will keep adjusted for a long period. The fuel valve, however, needs to be set about once every month. The principal reason for this is that the timing of the valve becomes late and the engine will not carry the load that it should. We found that these valves had never been set with the right lead until a man from the works came in one day and suggested that we try an earlier opening on them in order to get more power and when tried it was found to remedy the trouble."

"How were they in regard to carbon?" asked Hall.

"We were troubled considerably for a time, and then we began the kerosene treatment and then the rings had leaked badly so that the gases escaped into the crank case, after a time it almost stopped. However, it is necessary to pull out the pistons every little while and free the piston rings so that they will hold the high cylinder pressures."

"Did you have much trouble with the valves?"

"Not very much, although we ground the air admission and exhaust valves in every two weeks for a long while in order to be sure that they would be perfectly tight. This, we found from later experience, was too often and once in three months was quite sufficient. The fuel valves are tested by opening the indicator plug and listening for leaks with the air turned on. The points are made of nickel steel to prevent the oil from attacking them as it would a valve made of machine steel."



A TYPICAL OIL-ENGINE INDICATOR CARD

"Did you ever use the indicator?" was the next question.

"Not much," said Wallace, "for the diagram is not as essential with that type of engine as it is where steam is the power which drives it." Here he drew the sketch shown herewith.

"As you see, there are more lines used in this diagram as AB is the suction or air admission line, BC is the period of compression, C is the point of ignition, CD is the time that the fuel is being fed into the cylinder, DE is the expansion line, E the point of release and EF is the exhaust line."

"How were they on repairs?" asked Richards.

"I can quote what the erecting engineer put up to me, 'These engines require about four times the repairing that a steam engine does.' However, this should be qualified somewhat when we consider that a six-cylinder engine is like six simple engines placed side by side and when the number of parts increases so fast, mere adjustment takes some time. Many men have gained the impression that these engines could be operated by anybody and thus in many plants, inexperienced men were in charge of them, so that very poor results were obtained."

"What is the air used for?" asked the electrician.

"To spray the fuel into the cylinder, as the fuel pump will not drive it against the compression, and the air being considerably higher, feeds it in a fine spray which is ignited very easily. It is important that this air be kept at the proper pressure according to the load."

"On the whole, did you get satisfactory operation out of these engines?" asked the oiler.

"By what the manager said when I came to leave, I felt that we had done better than he expected we would," answered the engineer. "I had held no illusions in regard to my ability to operate them successfully," he added, "and while the erecting man showed us all that was possible, it was curious that things began to happen as soon as he left, that we had no specific instructions for and for some time we had to watch everything carefully in order to avoid shut downs; but by leaving nothing to chance and systematically repairing everything, we turned out a large amount of power with no shut-down that could be laid to the engine, so that when the water began to rise in the river we could look back on a hard winter with satisfaction."

"What will you tell us next?" asked the oiler.

"This is the seventh talk that we have had on my experiences in a country power station," said the engineer, "and while there is much that could be told, you have heard the most interesting part of them. For nearly 5 yr. I had directed the operation of that plant and I felt that there was a future in the oil engines, so I finished my work there and went to a plant where there was to be a large oil engine installation."

"We hope to hear of your experiences there," said Hall.

"They have already been told in the columns of Power Plant Engineering some years ago," the engineer replied, "so now we have other duties to perform and this will close the experiences in a country power station."

THE IMPORTANCE of preventing and stopping up air leaks is appreciated by all engineers. A very satisfactory medium for stopping these air leaks in the brick work of a boiler furnace is found in ordinary coal tar. The setting is first gone over with a ball of asbestos wicking and all apparent cracks are filled. The coal tar is then applied with a paint brush until about five coats cover the brick walls of a furnace. It is well to have the boiler in action at the time of painting so that there will be sufficient heat on the outside of the furnace wall to cause the brick to take up the tar. The new surface will be found to be pliable and yet not sticky. The big advantage in coal tar is that it is not costly and is far from being as crude as you might imagine. The effect on the fire is apparent as soon as the first coat is applied. —COMBUSTION CHAMBER.

How a Refrigerating Plant "Came Back"

IT WAS GOING STALE; NOBODY BELIEVED THAT IT COULD BE REFORMED. THEN CAME THE STRANGER WITH KNOWLEDGE AND VISION; AND WHAT HAPPENED

IT never was a big, model plant. But it was a good average installation, and for awhile gave satisfaction. Then it backslided. It was crowded too hard. Nobody loved it, and it went from bad to worse. E. W. Miller in Refrigerating World gave the facts about it from which the story was written.

THE OUTFIT

AT first it was a clean, well-behaved plant. Its main features were a 150-hp. combination fire and water tube boiler, with the usual trimmings; and this made steam for a 50-T. horizontal, double-acting compressor, a few pumps and a 150-kw. generating unit. The whole served a small packing house which handled 100 head of cattle a day, cooling a market storage room, chill rooms and a bunker room having some 2000 ft. of 1-in. pipe in cooling coils.

Above each coil was an iron trough such as is used with atmospheric condensers, to circulate calcium brine for keeping the coils clean and increasing their efficiency. This brine was circulated by a centrifugal pump, driven from a line shaft, which also drove a large fan to circulate air through the coils and through ducts to the chill room and market storage, where no coils were installed. The shaft was driven by a 7.5-hp. motor.

So much for the landscape of the plant. For a year it worked well, was respected and gained a good reputation. Its owner and the engineer treated it accordingly, and it lived a model life. Then came the gradual falling away from the path of virtue.

WHEN THE SLIPPING BEGAN

FIRST the boiler was overloaded, and the refrigerating plant was pushed to the limit, so that it couldn't keep cool in warm weather. Like anybody else who feels that he is slipping and gets hot about it, the plant began to lose out. And the boss and the engineer began to lose confidence. The boiler couldn't be shut down to be cleaned properly, so lost its neat appearance and effectiveness. The ice machine was run almost continuously, and developed a bad case of "fagged out." The coolers were heavily loaded Saturday, hence had to be run Sunday to bring the temperature down. Then the boiler was shut down, cleaned hurriedly while still hot, badly, of course, as it could be cleaned properly only by going inside. There was little rest for the plant; none for the men.

Of course nobody loved it, and the plant got a bad name about town. As many as four engineers in a month tackled it, but each one left as soon as he could get another position. That made matters worse. The plant became an "alley cat," kicked and cursed by everybody who came near it. And its decline became increasingly rapid.

Output of the plant had doubled, so no wonder the poor plant couldn't keep up. But that didn't help the fact that the chill rooms and storage were usually 10 to 15 deg. warmer than they should be. There was some hope, however, for the sharp freezers and the small storage which had direct expansion coils worked fairly well.

The calcium brine bath over the coils in the bunker room was not an unqualified success. Moisture in the air diluted the brine so that $85 worth of calcium had to be added every month or the brine became so weak that it froze on the coils. Even with that addition, there was considerable ice and frost on the coils all the time.

Changing keepers didn't add to the effective condition of the plant, either. Some were good, and tried, as long as they stayed, to effect some improvement. Mostly, however, they just kept her going, often feeding too much oil to the compressor to keep her from groaning, and thus clogging up receivers and expansion coils.

Things rapidly got worse. The condenser pressure jumped from 160 up to 200 lb.—and stayed there. Water consumption became a very flood, and coal consumption was frightful. Also ammonia seemed to disappear into thin air; from nothing during the first 6 mo. it leaped to 400 lb. a month at the end of the year. The boss "hollered," but no avail. Every new engineer asked for more ammonia and calcium the first thing. That would help a little, but soon the performance would drop back, and the disgusted engineer would quit.

ENTER THE STRANGER

WHO he was nobody knew. He just dropped in one day and applied for a job. The old engineer was quitting, and the boss grabbed at any salvation; and as chance would have it, the stranger knew his business. Consequently he looked over the plant, first.

TOO MUCH AIR

A TRIP to the roof and trying the condenser purge showed that half the condenser was filled with air and loafing. That was purged out and the stranger said, "Humph! Where did that air get in?"

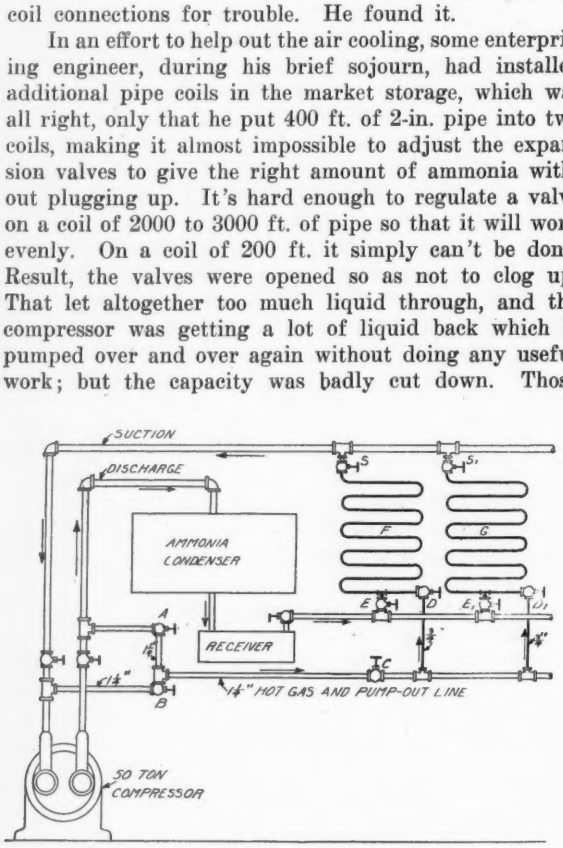
It seemed that it was a regular thing to pump down the system; and then, as the stuffing box began to get hot, to loosen up the packing as far as it would go. So there was one item found.

But he was not convinced that this was sufficient cause; and the gages were called in question. The suction gage was found to read 7 lb. too high, and the plant had been run at 5 lb. suction pressure by that gage; hence, it was actually running at all times with 4 in. vacuum, and when pumping down, 14 in. vacuum was actually pulled. That, with the loosened packing, was sufficient to account for the air. And the purging brought the condenser pressure back to 162 lb. after a little.

Expansion Grief

Now for that compressor. It was running ice-cold. The stranger squinted one eye and scratched his head; then started to trace out ammonia lines and expansion coil connections for trouble. He found it.

In an effort to help out the air cooling, some enterprising engineer, during his brief sojourn, had installed additional pipe coils in the market storage, which was all right, only that he put 400 ft. of 2-in. pipe into two coils, making it almost impossible to adjust the expansion valves to give the right amount of ammonia without plugging up. It's hard enough to regulate a valve on a coil of 2000 to 3000 ft. of pipe so that it will work evenly. On a coil of 200 ft. it simply can't be done. Result, the valves were opened so as not to clog up. That let altogether too much liquid through, and the compressor was getting a lot of liquid back which it pumped over and over again without doing any useful work; but the capacity was badly cut down. Those



CONNECTIONS FOR DEFROSTING AND PUMPING DOWN COILS

valves were closed down; then other valves adjusted to where they apparently should be.

Suction pressure jumped to 12 lb.; by a little further regulation it was raised to 15 lb., also the discharge from the compressor began to get hot. Things were looking up for the dejected plant.

Regulating the water, it was now possible to cut the flood to the condenser by more than half; so the pumps began to feel better, and some of the load being lifted, the boiler began to cheer up.

Too Much Capacity

Here was where the stranger gave the boss a jolt. Some time before the owner had decided that maybe the plant was at fault and had ordered another boiler and ice machine, of the same size as the old ones, and these were nearly installed. The stranger said: "You don't need 'em, except as emergency standby, and you ought to have had 'em for that right from the start. Fact is you haven't got enough expansion piping to be a proper load for the old machine, if the oil was cleaned out and the frost cleaned off." And he let that soak in for a day.

Then the boss came around with the question, "Well, what do you think we ought to do?"

And the stranger said he'd take 2400 ft. of 2-in. pipe with fittings, bends and such like for his. He would add this to the 400 ft. in the market storage, giving a coil of 2800 ft., which could be handled reasonably by an expansion valve without carrying liquid into the suction line, and would stop the bunker coils and fan from trying to do something they couldn't possibly do.

As a consequence the pipe came, rush; two fitters went to work; and in a few days the market storage was running at 33 deg. instead of 42 deg. The fan circulation was all turned into the chill rooms, and they felt better also.

It was easy, after that, to get a coil of 2500 ft. of 2-in. pipe put into the chill rooms, and in about 10 days the stranger turned ammonia into these; with the result that the coolers with a heavy load came down to 33 deg. by 3 a. m., the suction pressure was jumped to 25 lb., and the suggestion to run a 1¼-in line from the compressor discharge to the expansion coils for defrosting was adopted almost before he made it.

Defrosting

Connections were made as indicated in the diagram. The 1¼-in. line was taken from a tee near the compressor discharge, so that hot gas could be sent to the coils to be cleaned through individual ¾-in. connections. To defrost, valves E and S were closed and A, C and D opened. A few minutes of compressing hot gas into the coil did the work, when valves A and C were closed; E was opened, and the liquid ammonia which had condensed in coil F was fed to coil G, through D, used as an expansion valve. When frost began to show on F, return valve S was opened, D and D_1 closed, and E and E_1 reset for regular operation. The whole process took about 15 min. This method of taking the liquid out of the cleaned coil avoided any danger of getting slugs of liquid over to the compressor, as might be done if the valve S were opened with liquid in coil F.

Pumping Down

While he was at it the stranger put in a cross connection with valve B from discharge to suction. This could be used to pump down any expansion coil by closing its valves S and E and opening valves D and B without disturbing the other coils. Also like branch connections were made to the new compressor, so that one machine could be used to pump down if desired, while the other continued in normal operation.

As soon as the system was ready, every coil was given a thorough cleaning and defrosting. And it was possible to shut down the calcium brine circulation in the bunker room and save the monthly expense for calcium. By cleaning coils every few days, the oil was gradually loosened and removed, increasing greatly the effectiveness of the coils. For the first two weeks, half a pailful of oil was taken from the traps every morning, which was sufficient evidence of the coating that must have been in the coils.

Freezer coils that had carried a foot of frost were cleaned off, and the sharp freezer rooms dropped from 25 deg. to 20 deg. And it became possible to raise the back pressure much of the time to 28 lb. The compressor, which before couldn't hold the room temperatures within 15 deg. of what they should be when running at 85 r.p.m., was slowed down to 60 r.p.m. and carried its load easily.

The plant had "come back," and the stranger had become a valued friend.

Jumping Governors

CAUSES OF AND REMEDIES FOR IRREGULAR AMMONIA COMPRESSOR GOVERNOR ACTION. BY A. G. SOLOMON

THERE is no reason why the governor on a steam driven ammonia compressor should be "jumpy" any more than the governor on an engine connected to a generator or other load.

The load on a double acting ammonia compressor is practically the same during the complete revolution; and this is also true of the single-acting machine having two compressors. The weight of the flywheel will easily balance the slight variations.

A defective suction or discharge valve may cause a governor to jump; but when the defect is great enough to cause the engine to race, the trouble is very evident and easy to locate.

A slug of liquid entering the compressor from the evaporating coils could cause the engine to slow down, but the pounding will at once notify the engineer.

The cause of a racing engine or unsteady governor must be looked for in the governor itself, the belt or chain which drives the governor, the valve gear or the valve setting.

See that the belt or chain is not too loose or slipping. Examine the pulley on the shaft and on the governor for tightness. See that the gears are not loose or broken.

There is also a bearing which supports the weight of the upright governor shaft, and if this bearing is worn, the gears will mesh too close and cause binding.

The gag-pot may need adjusting or a different kind of oil may be needed. Use a moderately thick oil in the gag-pot and regulate the controlling valve or other device till the oil passes slowly from one side of the piston to the other. Some gag-pots are provided with one or more small holes for the passage of the oil. If the governor is too sensitive, plug some of the holes, or if there is only one reduce its size by bushing. If the governor is slow to act, increase the size of the oil passage or use a lighter oil.

See that the valve setting is correct. Use an indicator if one is obtainable.

Examine the valve gear for binding and for lost motion caused by wear.

Notice the toe plates on the back of the pick-up hooks. See that the riding edge is rounded so that it does not bind on the cam ring and stick. This defect is seldom found except when new toe plates are put on.

UNSTEADY GAGE HAND

THE VALVES on the gage lines are open too wide and the gage spring is subject to the variations in pressure when the piston changes its direction of travel.

It is a good idea to fill about 12 in. of the gage line with ammonia oil. This will act as a cushion and help to steady the gage hand. Just open the valves on the gage lines enough so that the hand will wave just a very little. Open the valves up wide once in a while to prevent their blocking up with oil or other foreign substance.

Harvard Engineering School

IN CONSEQUENCE of a decision of the Supreme Judicial Court of Massachusetts that the agreement of Harvard University with Massachusetts Institute of Technology to consolidate their engineering work was not in accord with the will of the late Gordon McKay, a new engineering school was established at Harvard, courses opened on Jan. 2 and will continue during the summer, so that students can complete a full year's work by next September.

Classrooms and laboratories are provided by the university, but arrangements may be made whereby facilities of other institutions will be utilized, especially for advanced courses. Terms of admission are the same as those to Harvard College for the academic and scientific courses, and a degree of S. B. in the branch of engineering chosen will be granted at graduation.

Instruction is offered in Mechanical, Civil, Sanitary and Electrical Engineering, Mining and Metallurgy and Industrial Chemistry.

Details may be had from Roger Pierce, Sec'y to the Corporation, Cambridge, Mass.

AMERICANIZATION is a process of education, of winning the mind and heart through instruction and enlightenment. From the very nature of the thing it can make little or no use of force. It must depend rather on the attractive power and the sweet reasonableness of the thing itself. Were it to resort to force, by that very act it would destroy its spirit and cease to be American. It would also cease to be American if it should become narrow and fixed and exclusive, losing its faith in humanity and rejecting vital and enriching elements from any source whatever.

Americanization is not something which the Government or a group of individuals may do for the foreign born or others. It is what these persons do for themselves when the opportunity is offered and they are shown the way; what they do for the country and the thing called democracy. The function of the Government and all other agencies interested in Americanization is to offer the opportunity, make the appeal and inspire the desire. They can and should attempt nothing more than to reveal in all their fullness the profit and the joy of working together for the common good and the attainment of our high ideals, to create the desire to have a part in the inspiring task, to show the way by which each may do his part best, and to help him set his feet squarely on the way.—P. P. CLAXTON.

Heavy Artillery as Field of Service for the Engineer

IT IS the common impression among practicing engineers that the Engineers' Corps is the branch of service in the army in which the education and experience of an engineer will be of most value. It is granted that this is sometimes the case, but it is desired to place before the engineering profession the opportunity that the Heavy (Coast) Artillery offers as a branch of service that will utilize to the fullest extent his technical training. There is no better way to illustrate this fact than to outline the successive operations an artillery officer is called upon to perform when a battery of guns takes up a position and opens fire on a target.

There is first the reconnaissance necessary to determine the exact location in which the guns will be emplaced. The higher artillery commander will designate a certain sector within which your position must be taken. Within this sector there will be a number of possible positions, and the reconnaissance is made to consider and weigh the relative merits of each location.

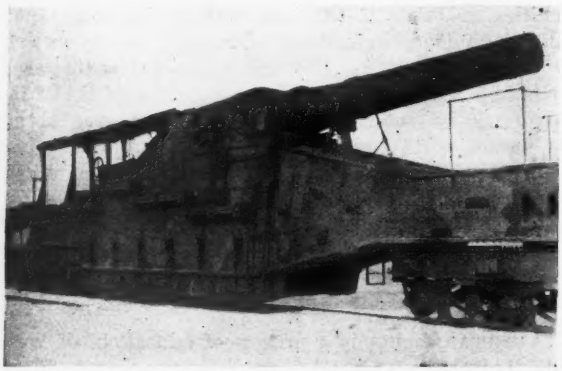


FIG. 1. A GENTLE PERSUADER READY FOR TRAVEL

A careful study of the existing maps will eliminate all but the three or four that are most suitable. A reconnaissance on the ground is then made. The question of accessibility for the bringing up of guns and subsequently for the transportation of ammunition are taken into consideration. Perhaps it is a railway gun, and each possible position for the spur has to be compared in view of the length of tract, the cut and fill and the time for construction required. Other elements that enter into the choice of position include the concealment afforded, the possible field of fire, whether all targets can be reached despite a sheltering hill which the projectile must clear. When the reconnaissance for battery position is completed, a similar study is made for the terrestrial observing station, from which the adjustment and result of our fire is observed. The engineer who has performed reconnaissance for railway locations, industrial or hydro-electric plants will appreciate this part of the artillery problems and realize of how much value will be his experience.

The reconnaissance completed, the battery is ordered to proceed to the selected site, and during this procedure the battery officer will start the topographic work necessary to establish the location of each gun. The co-ordinates may be determined by the solution of the three point problem, the known points being established geodetic points of known co-ordinates, which are to be found throughout the front in France. The co-ordinates may be established by plane table or transit transverse from points of known co-ordinates. Then there must be established a reference direction; that is, the angle that a line from a point of the battery to a distant visible point makes with the north direction. This is obtainable by observation on polaris, the sun or by running an angular traverse from a known direction. In a similar way the co-ordinates and reference direction at each terrestrial observing station must be secured. The battery is now ready to open fire on a specified target whose location is designated by co-ordinates.

If a condition of stationary warfare is existing, the

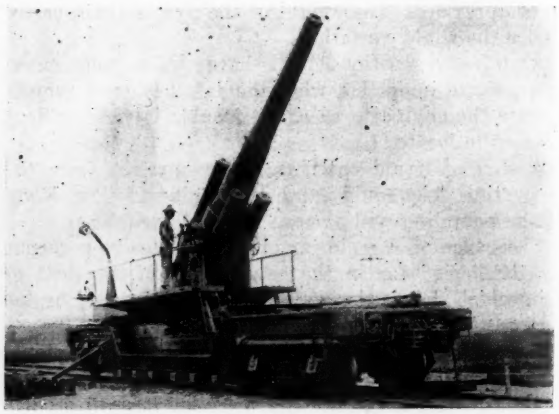


FIG. 2. TRAINED FOR A WING SHOT

battery position must now be developed. Dugouts for the battery commander's station and for the protection of his men must be constructed. This may involve constructing underground compartments to a depth of 20 to 30 ft., requiring timbering and shoring. Graphical plots of the battery position and the field of fire must be made. This requires extremely accurate draughtsmanship.

The operations mentioned above are those that have direct relation to engineering. Other operations that are purely artillery, but for which an engineering background is a very great asset, are the computation of the initial firing data and the adjustment of fire. The map range, which is figured by a simple trigonometric process, must be corrected for many external conditions: the barometric pressure prevailing, the temperature of the air, the temperature of the powder, the direction and intensity of the wind and other affecting factors. Adjustment of fire is the process by means of which the center of impact is brought upon the target. To understand the systems of adjustment used, one must be

familiar with the laws of probability and other mathematical principles.

We have made no mention of the mechanical knowledge an artillery officer must possess. His guns with their recoil systems and carriages are delicate pieces of machinery. He must understand them thoroughly and know how to take care of the minor repairs. His tractors, trenches and automobiles will require mechanical knowledge, for he has no garage to go to. They must always be in prime condition, ready for sudden orders requiring a long haul over rough roads.

When we add to the operations described above the battery commander's duties in company management, the housing, feeding and the discipline of his personnel, it is apparent that his activities cover a large field. Many of the operations must be carried on coincidently, and there are therefore few to which he can devote his time exclusively. He must distribute the duties, but supervise the whole, and to do this he must be an effective executive.

One final word as to why the heavy artillery offers to a red-blooded engineer an attractive field of service. As a member of the engineer corps his duties may bring him into no man's land carrying out underground mining operations, or he may supervise the construction of lines of communication under shell fire, but more than likely he will be constructing roads, railroads, docks, etc., etc., well behind in the S. O. S., or he may have a desk job buying or inspecting engineering materials. When a man is in the war game he wants it to take him to where the shells fly, and he wants to make some of the shells fly himself. The technical man should feel obliged to choose that branch of service where his experience is of most value. The engineer can rest assured that his ability will be utilized to the utmost in the heavy artillery.

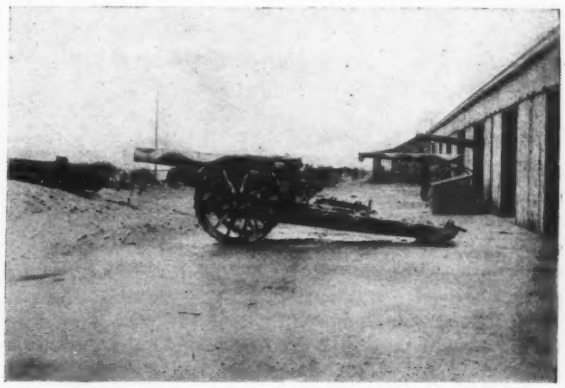


FIG. 3. SPOTTED TO AVOID BEING SPOTTED

A Program for Readjustment

DECEMBER 3 to 6, 1918, a meeting was held at Atlantic City of some 5000 of the most noted business men of the country to consider a program for readjustment of business to a peace basis. Besides general sessions at which addresses were given by industrial leaders and cabinet officials, and from which abstracts will be printed later, a committee from each industry met to consider its needs. The recommendations of these committees were reviewed by larger gatherings of related industries, and finally by 10 general groups. All recommendations then went to a clearance committee and were finally acted on by a general session, whose deliberations summarized the findings of the conference.

The conference was held under the auspices of the Chamber of Commerce of the United States, and as will be seen by the resolutions, the carrying out of the program was left largely to that chamber.

In substance, the conference declared for the following activity:

War Contracts and Restrictions

ALL WAR ORDERS made and accepted in good faith, whether formally executed or not, should upon cancellation be promptly and equitably adjusted and the amount ascertained to be due from the government promptly paid. If legislation is necessary it should be enacted forthwith by Congress. To expedite adjustment, officials who made contracts should remain in government service to participate in the readjustment.

War regulations and restrictions should be removed as speedily as possible except on preparation or distribution of foods, feeds and fuel, and on these as early as consistent with the welfare of this nation and the Allies.

Industries

AS A NATIONAL war necessity, some industries, relatively small, have been developed by large investment of capital and skill. Many large industries depend on these for supplies, and the government should at once ascertain what industries so developed are indispensable to our industrial structure and military establishment, then provide suitable means for their encouragement.

Reasonable co-operation between units of an industry should be permitted, under Federal supervision, to allow of elimination of waste and increasing efficiency. Appropriate legislation should be enacted to this end, the dividing line clearly defined between trade agreements that are and those that are not in restraint of trade, and an agency provided to rule for the government on applications of those proposing to enter into an agreement.

Local chambers of commerce should act promptly in regard to temporary conditions of unemployment caused by conversion of labor from war to peace work, and public works should be resumed to create opportunities for unskilled labor.

Application of the principles of the following creed in regard to industrial relations is urged on all units of industry:

1. Labor and capital are partners, not enemies; their interests are common, and neither can attain the

fullest measure of prosperity at the expense of the other, but only in association with the other.

2. The purpose of industry is quite as much to advance social well-being as material well-being, and in the pursuit of that purpose the interests of the community should be carefully considered, the well-being of the employes as respects living and working conditions should be fully guarded, management should be adequately recognized and capital should be justly compensated, and failure in any of these particulars means loss to all.

3. Every man is entitled to an opportunity to earn a living, to fair wages, to reasonable hours of work and proper working conditions, to a decent home, to the opportunity to play, to learn, to worship and to love, as well as to toil, and the responsibility rests as heavily upon industry as upon government or society to see that these conditions and opportunities prevail.

4. Industry, efficiency and initiative, wherever found, should be encouraged and adequately rewarded, and indolence, indifference and restriction of production should be discountenanced.

5. The provision of adequate means for uncovering grievances and promptly adjusting them is of fundamental importance to the successful conduct of industry.

6. The most potent measure in bringing about industrial harmony and prosperity is adequate representation of the parties in interest; existing forms of representation should be carefully studied and availed of in so far as they may be found to have merit and are adaptable to the peculiar conditions in the various industries.

7. The application of right principles never fails to effect right relations; forms are wholly secondary while attitude and spirit are all important, and only as the parties in industry are animated by the spirit of fair play, justice to all, and brotherhood, will any plans which they may mutually work out succeed.

8. That man renders the greatest social service who so co-operates in the organization of industry as to afford to the largest number of men the greatest opportunity for self-development, and the enjoyment by every man of those benefits which his own work adds to the wealth of civilization.

Organization of a Trade Association in each industry was favored to advise in regard to practices and policies, and every unit in an industry was urged to support its association.

Commerce

The two existing vacancies in the Federal Trade Commission should be promptly filled with able men of broad business experience to assist actively along constructive lines.

In the immediate problems of reconstruction we should make common cause with the Allies, dealing generously in the matter of raw materials and equipment to reconstitute their economic life; also providing credits through which they may make the necessary payments. Foreign trade should be encouraged by all appropriate means to produce industry that may afford employment to workers and prosperity to the nation. Vigorous development of commercial and financial association with our neighbors of North and South America should be encouraged, and the work of the Pan-American Union continued and broadened.

Industries are urged to provide opportunities for young men to obtain an education in foreign languages, business methods and habits to meet the larger opportunities opening in international commerce; also government departments and educators are urged to give facilities for such work.

Taxation and Federal Control

Congress, in the passage of new revenue legislation, should give careful consideration to the views of commercial and industrial organizations, in order to readjust inequalities in the present tax law. Ability to pay, inventory values, proper reserves and revenue required under the new conditions are matters of vital importance to business interests.

The large stocks of raw materials and finished products carried to meet extraordinary requirements have, in large part, been acquired at abnormal cost, and are, therefore, carried on the books at inflated values which should not be used as a basis of taxation. Congress is urged to allow for deduction from apparent profit to create a reserve for shrinkage in values, safeguarding the interests of the government by fixing a maximum percentage of deduction and by proper methods of inspection and appraisal.

Government ownership and operation of telegraphs, telephones and cables was opposed, and the early return of railroads to their owners, under Federal charter and with regulations permitting elimination of wasteful competition, pooling of equipment, combinations in the ownership and operation of terminals and such other practices as will tend to economy without destroying competition in service was advocated.

Merchant Marine

Continuance and increase in the construction of a great merchant marine was favored, with operation under American control, kept safe by legislation to insure stability and lasting value to American industry.

Also recommendations of the Post and Harbor Facilities Commission of the U. S. Shipping Board were supported; that a local commission be created for each important port, having representatives of industrial, commercial and railroad interests centering at that port, and that facilities be installed to meet local needs and those of foreign vessels. And that a zone system be arranged by which exports and imports would flow through the ports within economic transportation distance of the points of origin and destination.

Our ocean tonnage must supply our troops overseas and help provision the inhabitants of devastated regions, and such part of our tonnage as is not required for these needs, and vessels of associated countries in like situation should be entered in the common service of all nations, to secure to them their immediate needs for food, raw materials and transport of products.

Water Powers

Industrial activity depends upon the available supply of power. A bill dealing with development of hydro-electric power upon waterways and lands subject to Federal jurisdiction is now before a committee of conference of Congress, and that committee is, therefore, urged to arrive at an acceptable form of legislation in season for enactment at the present session of Congress.

European Commission

Business men of the U. S. have devoted their energies and resources toward winning the war, regardless of sacrifices. They appreciate the necessity of continuing the effort that the world may be restored to normal conditions as quickly as possible, and to accomplish this will require co-operative effort and common counsel of the great commercial and industrial powers of this country and the Allied nations.

To contribute to the fullest toward the prompt solution of the problem, the Chamber of Commerce of the U. S. is requested to enlist the co-operation of national bodies in the appointment of a commission, representative of American business, which shall proceed to Europe without delay and establish machinery for the following purposes:

A.—To study the reconstruction needs of European countries in conjunction with business men of those nations in order to advise the business men of the United States as to how they may be most helpful in meeting the needs of Europe and caring for the interests of American industry and commerce.

B.—To be available to the peace delegates of the United States for any needed information which they may be able to present or for any other aid which may be given by the business men of the United States through the medium of such a commission. The Chamber of Commerce of the United States is also requested to appoint members of the Commission to represent the business men of the United States at the forthcoming meeting of the Permanent Committees of the International Congress of Chambers of Commerce.

Council and Executive Committee

Continuance of the War Service Committees was recommended and the organization of other committees for industries not now represented. The Chamber of Commerce of the United States was requested to appoint an Executive Committee to relate the efforts of all War Service Committees, to assist in carrying out the recommendations of the conference and to secure the service of such leaders of industry as may be called upon to act.

Chairmen of War Service Committees are to serve as a Council, advisory to the Executive Committee, and to tender their services to assist the War Department in the distribution of accumulations of raw materials and supplies so as to interfere least with normal industrial conditions.

Resolutions not acted upon were referred to the Chamber of Commerce of the U. S., for review, and thanks tendered to the Associated Business Papers, Inc., to the Business Press generally and to speakers who had addressed the conference.

Heroes of the Engine Room

In his report of the torpedoing of the U. S. transport Mt. Vernon, Captain Dismukes pays a well-deserved tribute in the Chicago Tribune to the unseen heroes of the fire and engine rooms, who braved the triple danger of explosion, drowning and scalding, with least chance of escape of anybody on board ship.

After describing the first alarm, he says:

Torpedoed

"I rushed to the bridge and was halfway up the ladder when the blow struck us. It seemed that the whole ship was lifted out of the water and torn to pieces.

"On reaching the bridge I looked over the side and saw that the ship had settled in the water 10 or 12 ft., but its great momentum was still carrying it through the water at the standard speed.

"I communicated at once to the engine room and found that the telephones and speaking tubes were still intact and that the engines were still running, but they reported that the fire rooms were flooded.

"My own impression was that the ship was not going to sink. I based that impression on the fact that I, like every other officer and man on the ship, was fully indoctrinated with the belief that our ship would not sink, because we had made every precaution to meet just this emergency.

"This preparation had consisted in sealing up all of the ship's watertight compartments, keeping the doors shut, although by doing so it put the men, especially the firemen in the fire room, to a great hardship.

"To run with them shut meant practically inclosing the firemen in the fire rooms in traps, from which there was no exit except by 65 ft. of tortuous ladders up overhead through a maze of steam pipes to the upper deck. All electric light wires were torn away and the fire rooms were thrown into instant darkness.

Firemen in Deadly Peril

"The men in these fire rooms in the utter darkness knew that they were in a trap. They also knew that the ship was in imminent danger of going down. They knew, furthermore, by the intuition that all firemen have, that the boilers were in danger of exploding.

"One of the water tenders jumped to his feet and said: "Boys, hold what you've got; that is only one torpedo, and with that he opened the furnace door and got out some of the flaming coal and held it up to the water gage to see whether there was any water in the boiler.

"He saw there was no water, and therefore knew that they were in danger of being blown up by the boilers.

Every Man Stuck to Post

"Did any of the men rush for exits to escape? Not a man. Their sole endeavor, from the water tenders down to the lowest fireman, was to stick to the post and get water into the boilers, and after the water was got into the boilers, to rush the fires to make all the speed possible.

"The duty of the men off watch was to go below to help those that were on watch, and I am happy to say that every man whose duty it was to go below did so. Instead of going out of the fire rooms into safety, the men were going down into these dark holes to do what was their duty.

"There were several instances of peculiar heroism. In one of the fire rooms that was flooded there was a chief water tender named C. L. O'Connor. O'Connor was thrown to the floor plates.

"He made a dash, although almost mortally burned, to close the hydraulic lever; that is, to operate a watertight door leading from the fire room into a large coal bunker holding about 1200 tons of coal.

"Unfortunately the explosion had deranged the hydraulic system by which the doors were operated and he was not able to close it. The men in that bunker were drowned, but it was not O'Connor's fault.

Heroes Save Ship

"One other man in the fire room was saved, and he had a most interesting experience. He was Hoke Smith, a nephew of the former secretary of the interior. He, like O'Connor, was thrown up to the grating above, and was sucked down through the door which O'Connor tried to shut.

"Smith finally attracted the attention of those on deck, and some mechanics cut a hole and got him out. Others with him were drowned.

"Meanwhile the danger of the boilers exploding had passed, thanks to the heroic men in the fire room, who kept them going with water and coal. The ship listed terribly, but it continued to make headway through the night, and the lights of Brest were finally sighted."

Electric Light and Power Plants at Antung

By Consul John K. Davis, Antung, China

DURING the first week in July the electricity department of the South Manchuria Railway Co. commenced the construction, immediately to the west of the Japanese Settlement at Antung, of a new electric light and power plant, the cost of which is estimated at the equivalent of $210,000 United States currency. Two generators, each of 1000 kw. capacity, have been purchased from an electric power company in Japan, which has itself now purchased new dynamos.

The electricity department of the South Manchuria Railway Co., which is the only company furnishing electric light and power in this consular district, already operates two plants in Antung. The first of these is located in the Japanese settlement, but immediately adjoining the Chinese city of Antung, which it supplies. The engines and generators are of German manufacture, the motive power is suction gas, and the total daily output is 2600 kw.-hr. The fuel used in the first plant is coal and that used in the second coke. The current as delivered at points of lighting is 110 v. and 50-cycle alternating. At present these two plants are unable to supply the existing demand for current which, during the past two years, has grown greatly as a result of the continued high cost of kerosene oil.

The following figures for July 27, 1918, give an idea of the demand for electric current in Antung:

For Light—	
Number of buildings in which electricity is supplied without meters	2,239
Number of buildings supplied with meters	1,080
Total number of buildings in which electricity is used	3,139
Number of lights installed without meter	11,979
Number of lights installed with meter	20,415
Total number of lights installed	32,394
For power—	
Number of motors in sawmills, 17; total horsepower	136
Number of motors in rice mills, 6; total horsepower	15
Number of motors in machine shops, 5; total horsepower	28
Number of motors in pumping stations, 2; total horsepower	220
Number of motors in miscellaneous use, 7; total horsepower	16
Total number of motors in use, 37; total horsepower	415

The rate charged for electricity is 25 sen (12½ cents American currency) per kilowatt-hour, subject to a 10 per cent discount for the payment of bills at the company's office within the first seven days of the succeeding month, and with a minimum monthly charge of 30 sen (15 cents) per light. The rate for power use is 6 sen (3 cents) an hour per contracted horsepower up to 200 a month, and 4 sen (2 cents) an hour per contracted horsepower over 200 hr. a month.

While the new plant will, of course, remedy the present insufficiency of current for lighting purposes, it is intended primarily to furnish motive power for several new manufacturing enterprises which it is expected will grow up in its immediate vicinity. The first of these will be the Anto Yoko Silk Mill, in which it is planned to spin silk waste. —Commerce Reports.

The value of the minerals produced in the United States in 1917, according to the United States Geological Survey, Department of the Interior, was $5,010,948,000, an increase of $1,496,976,000, or about 43 per cent, over the former record—$3,513,972,000—established in 1916. The blast furnace products (pig iron and ferroalloys), copper, coal and petroleum contributed 74 per cent of the total value of minerals produced and 88 per cent of the increase in 1917.

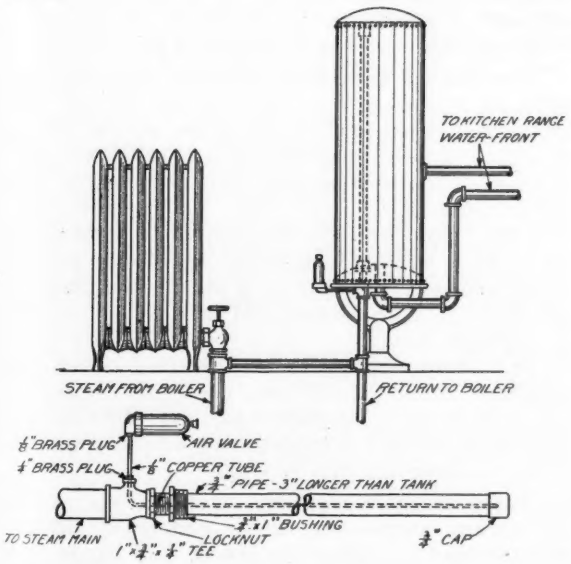
The metals established a new record in 1917, being valued at nearly $2,092,000,000 and representing 42 per cent of the total value of the mineral product. They showed an increase of about $471,316,000, or 29 per cent, over the $1,620,508,000 reported for 1916. The blast furnace products contributed nearly 90 per cent of the total increase. Increases were also made in the value of aluminum, copper, lead and silver, but decreases were recorded in the value of gold and zinc.

The value of the non-metallic products in 1917 was 58 per cent of the value of all minerals produced, increasing $1,010,459,000, or nearly 54 per cent, from the former record of $1,878,464,000 in 1916 to $2,888,923,000 in 1917. Of this total increase coal alone represented nearly 66 per cent, and coal and petroleum combined contributed about 85 per cent.

Putting Steam Pipe in Range Boiler

IN READING the Letters Direct from the Plant articles, I am reminded of something I worked out in my home that has been working successfully for over 3 yr. It may be of value to others, and could be used in any steam heating plant to furnish hot water to building, without the cost of installing a heater or a manhole tank in order to put a coil inside.

My 30-gal. range boiler was connected to the kitchen range, and my heating boiler was a vertical water jacketed boiler, with no provision for inserting a coil, so as a result I had no hot water unless the range was going.



STEAM PIPE IN RANGE BOILER AND DETAILS OF PIPING

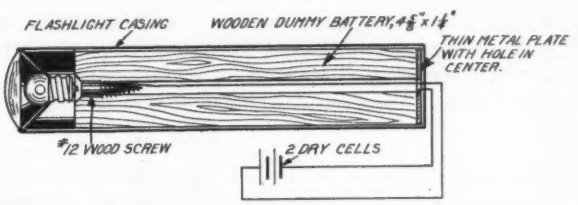
First I disconnected the range boiler and then drilled and tapped it as near the center of the bottom as possible for a 1-in. pipe. Then I took a piece of ¾-in. pipe and threaded one end for a ¾-in. cap, put on the cap and ground it off on the side until it would just pass through a 1-in. fitting. Then I cut off the pipe so it was about 3 in. longer than the inside of the tank, and threaded it up until the distance from the end of the thread to the end was 1½ in. shorter than the distance from the top to the bottom of the tank, inside; then I put on a 1 by ¾ in. bushing with the top away from the cap, and placed a ¾-in. lock nut in under the bushing to draw up against the tee, to be put on later.

Then next I took a 1 by ¾ by ¼ in. tee and screwed on the end and tightened the locknut up against the tee. The next thing was to get a piece of ⅛-in. oil tubing (it can be had at any auto supply store) and ¼ and ⅛ brass plugs and drill them so they will just slip over the oil tube. Then push the oil tubing through the ¾-in. opening of the tee and up the capped pipe until about 1 in. from the cap, slip on the drilled ¼-in. plug and tighten it up, then the ⅛-in. plug the opposite way and solder them to the tube (the ⅛-in. plug goes on the end for the air vent). Take a tee of the proper size and a close nipple and connect to the tee already on the pipe (the latter tee for the steam and return) and your heater apparatus is made up. Stand the tank on end, bottom side up, and shove the capped pipe through the tapped hole and screw it in by means of the ¾ by 1-in. bushing on the pipe; then go ahead and connect up the tank and heater pipe. If possible, it is preferable to connect up the copper air vent tube to some sewer opening to avoid the drip, although mine is not. Of course there can be variations in the connections as long as the heater part is made as outlined.

CHARLES H. FREEMAN.

Extending Usefulness of Flash Lamps

FOR SHORT-PERIOD SERVICE the flashlight is all that can be desired; but when it comes to working for a half hour or longer, especially if the battery has been in use for some time, sustained effort proves too much for the



SECTIONS THROUGH FLASH LAMP SHOWING ARRANGEMENT EMPLOYED FOR USE IN CONNECTION WITH PORTABLE BATTERY

diminutive battery. To overcome this as well as to secure greater economy in the use of batteries, the writer developed the following scheme.

An ordinary flash lamp is tapped at the center of the rear-end cap by making a ¼-in. hole. A cylindrical block of soft wood 4⅝ in. long, 1¼ in. in diameter, with a longitudinal central hole ¼ in. in diameter, replaces the battery proper. A pair of wires of suitable size or light flexible cord is passed through the opening in the rear end of the flash light case one wire passing through

the wooden cylinder and connecting with a No. 12 flat-head wood screw which forms the top contact. The other wire is placed under the disk of sheet metal, this disk being fastened to the bottom of the wooden cylinder by four small tacks. The connections can be soldered if desired, as it makes a better job, but it is not really necessary. The extension wires connecting with the No. 6 cells can be made of any length that may be needed.

One distinct advantage connected with this scheme resides in the fact that, owing to the large size of the batteries used and the low current consumption of the flash lamp, the effects of internal resistance and polarization are practically nil. In the ordinary flash battery with even a very small current flowing the effects of drop due to internal resistance are distinctly appreciable. In regard to economy, it goes without saying that the No. 6 cell can furnish vastly more service for a given amount expended than is the case with the smaller sizes of battery.

T. H. Reardon.

Lower Cost of Hot Water

In the Dec. 1 issue, on page 971, I notice an article on heating water by gas and effecting a big saving. Mr. Tompkins does not say what he was paying for steam, neither does he say how much he is paying for gas, or how many degrees he is raising the temperature of the water.

We have installed two 2000-gal. Alberger heaters, and raise our temperature approximately 100 deg., and our cost runs very nearly $0.44 per thousand gallons. We buy our steam from the central station, at current rates; on checking up the cost to raise the same number of degrees by gas it would cost $1.12 per thousand gallons.

It appears to me that the price of steam, in this case, must have been enormous, or else the price of gas is extremely low.

We had a case of trouble with our heaters, where the water to be heated was leaking into the steam space through a faulty gasket and was being registered on the steam condensation meter. Mr. Tompkins may have a similar condition, as I am unable to check up such a saving as he speaks about by changing from steam to gas.

A. H. Betwee.

In reply to your inquiry, I beg to advise that if Mr. Betwee will study the drawings in the Dec. 1 issue, page 971, he will see that the necessary valves have been installed for shutting off the 750-gal. heater when the 90-gal. gas heater is put in service. The cost for steam for keeping the 750-gal. heater in service during the month of July, 1918, was $132.99. It cost $16.32 for operating the 90-gal. gas heater during the month of August, 1918. The difference between the operation of the 750-gal. heater by steam and the 90-gal. gas heater by gas is the cause of the great economy effected. The temperature of water when either heater is in use is 180 deg.; therefore it will be understood that when the gas heater is in service the large heater is cut out of service, and when the large heater is in service the gas heater is cut out. The cost of steam is about 80 cents per 1000 lb. The cost of gas is 80 cents per 1000 cu. ft. The large steam heater has no leaks, as suggested by Mr. Betwee.

Clarence S. Tompkins.

Repairing Bagged and Ruptured Boiler Tubes

An article in reference to the repair of bagged and ruptured tubes in water-tube boilers, appeared on page 285 of the Aug. 17, 1918, issue of the "Electric Railway Journal," as follows:

"In the boiler rooms of the Doherty properties in Toledo, Ohio, all bagged and leaking boiler tubes are being welded by the oxy-acetylene process. William Long, superintendent of production, states that as many as 14 welds have been made on one tube before it was discarded. The process is first to heat the bag on the tube, with the torch, using a slow heat until the bag is a bright cherry red. The bag is then driven back, beginning at the outer edge and working in toward the center. In case there is a hole in the bag, this is first welded shut. Boiler tubes are also being reclaimed by welding sections of tubes on to damaged tubes that have been removed. The cost of welding is approximately $0.75 per single weld, including all labor, material and cost of setting up the apparatus. When several welds are made on one boiler, the cost is less.

"Crystallized boiler tubes are also being successfully annealed by use of the oxy-acetylene process. The two ends are heated to a bright cherry red and allowed to cool, after which they are rerolled and given a hammer test. After treatment the tubes are found to be as soft as new ones.

"The Toledo Railways and Light Co. reports that by use of these methods a great saving is being made in boiler tube costs. The process is another illustration of the extent to which modern welding is being applied in all technical fields."

This article appears to have received rather wide publicity. It has recently been quoted in a letter sent out by W. G. Williams, district engineer, Mid-Continent Division, U. S. Fuel Administration, evidently with the intent of conserving tube material.

Boiler insurance engineers, however, believed that any general introduction of the methods of tube repair proposed in this article cannot help but increase the already too numerous accidents caused by tube failures in water-tube boilers.

There is a class of tube accident which occurs in connection with water-tube boilers with more or less frequency, which is produced by the blowing out of a piece of the tube, and while it is difficult to assign a definite cause for this class of accident, it may be most logically explained as being produced by repeated local heating and cooling of the failed section. It would appear that in a structure as rigid as the ordinary boiler tube the proposed method of welding and driving up small bags, as practiced by the Toledo Railways & Light Co., might contribute to this class of accident, due to severe internal stresses that may be produced by local heating.

Welds made in the manufacture of welded-type

boiler tubes are frequently the cause of tube accidents. The best engineering practice requires the use of seamless tubes for water-tube boilers, or at least that the first few rows of tubes exposed to the products of combustion and which are the ones generally concerned in tube failures, should be of the seamless drawn type.

Owing to the fact that tube accidents are often accompanied by loss of life or serious personal injury to the attendants, besides a large amount of property damage, it is believed that only the best material should be used for tubes, especially in boilers of the water-tube type.

Tube failures are of such frequent occurrence that the engineers of the companies doing steam boiler insurance business feel that the danger should not be increased by this practice of heating and welding.

STEAM BOILER AND FLY-WHEEL SERVICE BUREAU.

Trap Failure Problem

IN looking over Dec. 15 issue, I notice that Mr. Haight still insists on the float trap.

Well, everybody to his taste—float or bucket. I don't bypass through the medium of the blowoff, as I think the water is foul enough for the boilers without.

My experience covering some years has been that the float trap seats cut or scored and on light loads the water would be exhausted in the trap body and steam would follow.

Then again if you are looking for low temperatures in trap discharges, why not use the expansion type? I have taken discharge water from an expansion trap as low as 120 deg. F., and still kept the system clear, but in an emergency it was not there. I have traps working on 150 lb. that may whang some, but they keep on the job day and night and if a seat or disc or both need to be replaced just 15 min. by the chronometer does the business.

Remember that it isn't a case of one or two traps or of ½-in. traps, but high pressure traps up to 2½ in. and plenty of them.

Will a repair man attend to a trap on the spot at 5:30 p. m if he knows it will take him 2 hr. or more, or will he let it go till morning?

If he knows 15 min. will do the trick and then the job is over, will he do it?

He will.

I have done repairs and I know whereof I speak.

TOM THUMB.

Firing Experiences

IN ALL the engineering magazines (I take three in all) there are frequent articles on firing. Many are very good, some are practical, others theoretical. To my mind the ones that are most appreciated are the ones from the firing line; that is, in front of the boilers.

In my plant, from 5 p.m. to 7 a.m., only one engine is run. It has been customary to keep both boilers fired 24 hr. and the dampers partly closed. With the coal we use the third trick man got four to four and one-half loads of ashes. I cut out one boiler, and increasing the draft slightly on the other, carried the load easily; result, the third trick now gets three loads of ashes. The saving in coal is easily seen, but as no provision for weighing is in use here I cannot give the amount.

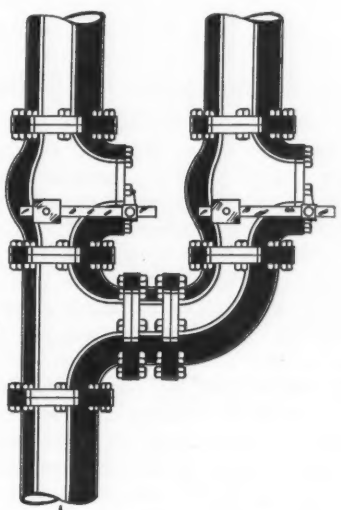
In our plant we have a very strong draft, greater than necessary for ordinary loads. We use the damper (hand) having 4 points for adjustment. It requires more frequent firing; but that part is all right, as I do not believe in loading a fire box, and can show better economy with spreading than coking fires, in spite of the fact that many advocate them.

Many articles on firing are amusing. For instance, engineers were advised to instruct their firemen in amount of war material that one ton of coal would create, and we were told one ton would pull a 50-car freight train 50 miles. Now I've fired many a freight and passenger engine on various roads and never found one where two tons would take me over a 100-mi. division. I am an advocate of strong draft and checked damper, and then a fire 4 in. thick is all I need to make the boiler develop full steaming capacity.

JAMES C. LEE.

A Duplex Relief Valve Installation

IN ONE PLANT with which the writer was connected, a number of cooking vats were in service, operating on exhaust steam. A maximum pressure of 5 lb. was carried, any higher pressure being undesirable because of the light construction of the steam drums in the vats. As originally installed, the exhaust line to the vats was provided with a back pressure valve with the weight set to carry 5 lb. maximum pressure. On several occasions it was found, however, that, due to sticking or sluggish operation of the valve, the necessary relief was not provided, resulting in the straining of the vats. After several occurrences of this kind, we hit on the scheme of providing the valves in duplicate so that a double meas-



WITH THIS ARRANGEMENT POSITIVE PROTECTION WAS ASSURED AT ALL TIMES

ure of protection was available. This was neatly and conveniently done by inverting a tee in the 6-in. vertical line and connecting the side outlet to another relief valve by means of a nipple and elbow, all as shown in the accompanying sketch.

M. A. Saller.

Testing Small Motors

In manufacturing plants where many small motors are used, they are sent to the electrical department for repairs. These motors are often sent back to their respective department, without being tested. In order to be fair to the motor and to the repairman, we insisted that every motor be tested thoroughly before being sent back. We kept these motors on a 2-hr. test, the same as the A. I. E. E. recommendations. The motor to be tested was belted to another motor, which was connected up to act as a generator. The power obtained from this generator we used to drive another motor. When the first motor was relieved from the test, the second motor or generator was placed on test, and the other motor moved to the generator place. By replacing the motor with another, it was possible to test thoroughly all motors. This seems to be a long method; but it has proven its worth many times, as the motor when heated developed many faults that would only show up under such conditions. Many times, a new set of fields test out O. K. but when heated, develop something wrong. It also acts as a very good check upon the repairman.

Dean B. Cobb.

Running Alternator with One Collector Ring

On shutting down a 1250-kw. turbo generator one evening, I noticed a series of sparks shooting out from the collector rings. After the machine stopped, an examination was made, and it was discovered that the lead from the outside ring was burned off close to the inside ring. As is known, the lead from the outside ring passes through the inside ring close to the shaft and is clamped to the shaft as it passes along to the field winding, the other lead coming from the field winding in the same manner to the inside ring.

Nothing was left of that part of the lead from the ring whereby a repair job could be made. A new set of rings were on hand. Our first intention was to take the old rings off and install the new set, which was going to be a big job for us, as we did not have the tools on hand for a job like that. After a little thought on the part of the chief electrical engineer, a simple way was worked out which overcame the difficulty. The end of the broken lead was cleaned and clamped tight to the shaft; the lead coming from the exciter bus bars was disconnected from the brush holder of the ring and connected to the frame of the machine, which cut out the ring entirely. The machine was started up and the field switch thrown in, the voltage built up as usual; it was then put in service, and everything was O. K. That happened 2 mo. ago and we are still running with one collector ring. The path of the current now is from the positive bus bar of the exciter to the inside ring through the field winding, through the shaft and frame to the negative bus bar. Note this is a revolving field type machine and the collector rings are exciter terminals only.

David Fleming.

Long Jaw Toggle Clamp

One of the boys made up a couple of long jaw toggle clamps in odd times when things were running well, and they have proven pretty handy at the bench and on repair work, so I have roughly sketched the

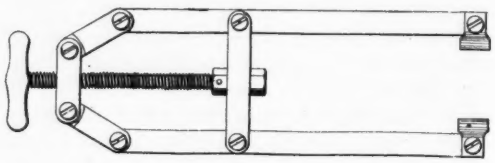


FIG. 1. ASSEMBLED VIEW OF TOGGLE CLAMP

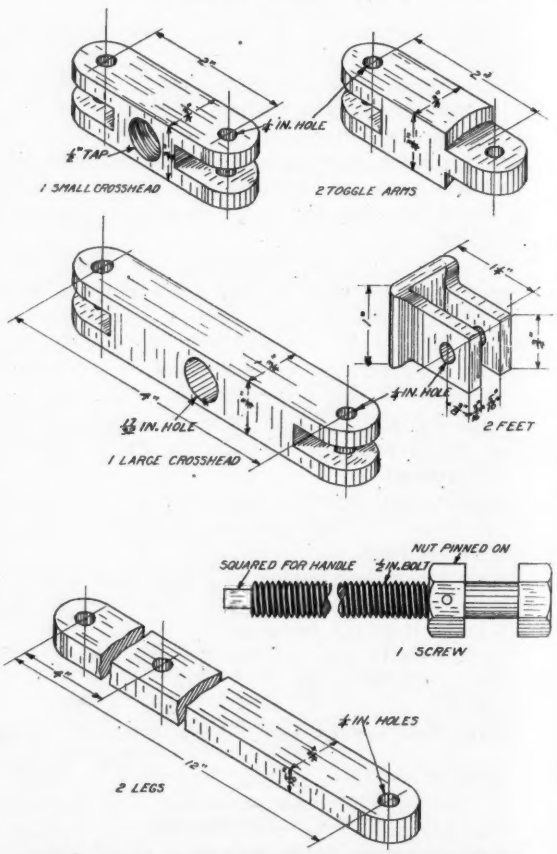
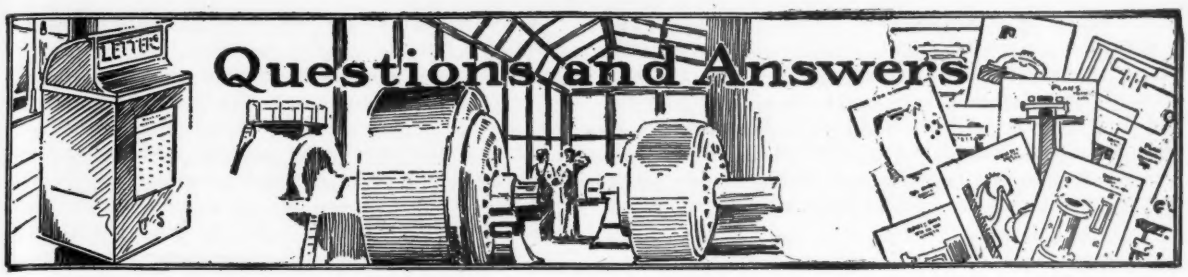


FIG. 2. DETAILS OF PARTS USED IN TOGGLE CLAMP

details and given the dimensions, for there may be some who would like to add such a clamp to the tool kit. It is all made of odd stock. Anybody handy with tools can make it.

C. H. Willey.

Hate may start a war, and hate may win a war, but only charity is equal to the task of restoring and maintaining peace.



Engine Operation Problems

RECENTLY an engineer friend of mine got into a discussion with me about valve setting. He claimed that it was impossible to get as clear and sharp an exhaust from a piston valve engine of the Fitchburg or Fleming-Harrisburg type as it was from the old plain slide valve of the D type. I claim that you can if the valves and valve chambers are in the condition they should be and the valves properly set. I would like to see this subject discussed through the columns of Power Plant Engineering.

MACHINIST.

Oil Burning

ON PAGE 893 of the Nov. 1 issue, H. Armstrong wishes to know if there is a smoke law in my locality. There is none, and none needed; but I don't see where he gets the idea that I admit no air to the furnace. There is plenty of air space left at the front of the grates, and after the fire is lighted the damper in the stack is closed, or as nearly closed as practical for complete combustion. No smoke is seen at top of stack, yet a small amount of smoke indicates good economy. It is next to impossible for me to make an evaporation test in my plant, which I agree would be more accurate; but as I pull a flour mill, there is a close record kept of all products turned out. Mr. Armstrong does not state whether he runs with the damper in the stack closed or open, but I take it for granted it is wide open. I suggest that he make an evaporation test with it wide open, also a test with it as nearly closed as possible for complete combustion and report the result. We want all we can get from fuel oil at this time, and there is no nearer cut to it than by experimenting.

READER.

Operating Clocks on High Voltage

ON PAGE 1013 of the Dec. 15 issue, I notice the inquiry from J. S. regarding the operation of time recording clocks on high voltage.

Evidently the clock mechanism is designed for the 18-v. battery current. Cutting down the 110-v. through a resistance would be injurious to the contacts in the clock, as a long arc would be drawn at the contacts each time the circuit was broken, due to the fact that as the current is reduced through the arc, the drop is less through the resistance, increasing the voltage at the arc.

I would advise him to connect up a battery to the 110-v. direct-current line through a lamp bank as shown in the accompanying sketch. Then connect the same battery with the clock circuit. This will give slightly over 18-v. on the clock circuit at all times.

The number of lamps in the battery charging circuit should be so adjusted that during the day the battery receives a little more energy than it gives out. This will take care of the current required for operating the clocks on Sundays and nights.

It may not be necessary for J. S. to waste the power taken up by the lamp bank. If he has an unimportant light circuit carrying about the right number of lamps which is in use all day, he can connect his battery in series with that circuit. I say unimportant because the voltage will be reduced 18 or 20-v. at these lamps.

I have seen this method used on ships where the alarm bells and rudder indicator were operated by a storage battery. The battery would be connected in the circuit feeding the lamps down the shaft alley and would be continuously slowly charging.

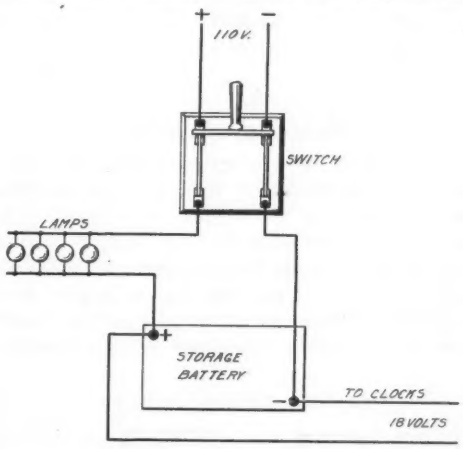


FIG. 1. DIAGRAM OF CONNECTIONS OF CLOCK BATTERY AND CURRENT SUPPLY LINES

FRED H. WITTERS.

IN ANSWER to the inquiry of J. S. regarding operating clocks on high voltage, I beg to state that he could operate his clocks automatically if he would connect them up according to the accompanying diagram, Fig. 2.

The relay can be rigged up of one or two coils from any discarded equipment, motor starter or circuit breaker, etc. Screw a number of lamps into the row of sockets that will deliver at least twice the current of that indicated on ammeter so there will be enough energy in the battery for night operation. If, for instance, the ammeter shows 2 amp., screw into the row of lamps from eight to ten 60-w. lamps. This will de-

liver from 4 to 5 amp. in your system; two for clocks and three to be stored up in the battery with the generator running and line switch closed. With the current off, the relay will drop, break the charging circuit and the batteries will then furnish the current. A storage battery should not be allowed to remain idle for any length of time. By use of the double throw switches either of the two batteries may be used and

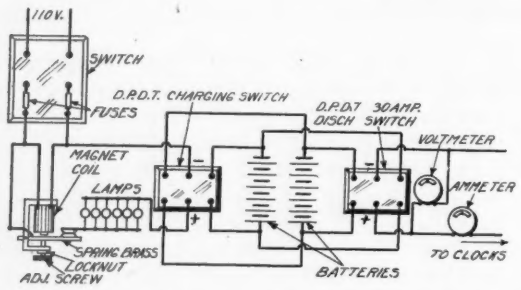


FIG. 2. SCHEME OF CONNECTION SUGGESTED BY FRANK BUDIG FOR OPERATION OF CLOCKS ON HIGH VOLTAGE LINES

thus avoid damage to them, or have one ready for repairs. If desired, the diagram could be simplified by using plain switches or even solid connections.

FRANK BUDIG.

Why the Pound?

I SAW C. W. A.'s article in the Nov. 15 issue and some of the answers to it, including his explanation of how he overcame his trouble in following issues. This may be well and good for a makeshift, but according to the sketch on page 936 the heater is not connected to get the most out of it, and this may be in part the cause of the pound. The right way to run the feed lines would be to connect the discharge from the boiler feed

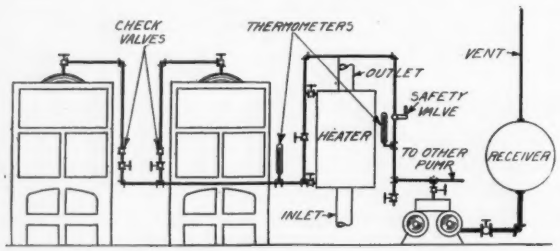


FIG. 1. FEED LINE CONNECTIONS AS SUGGESTED BY CASEY JONES

pump to the top of the heater and the outlet to the bottom, where the exhaust steam enters it. (See Fig. 1.) The vent on the receiver is usually small and could be blocked up by corrosion or the water may run so low as to allow the pump to take in air. A good preventive for this is to connect a small tank or barrel to the suction, as shown in Fig. 2—the ball cock could be set so as to open when the water is low in the receiver, allowing make-up water to enter and keep the pump from taking in air.

CASEY JONES.

WHEN TAKING CHARGE of the plant I am at present operating I found the boiler feed line piped up in practically the same manner as that of C. W. A. I also had trouble with pounding in this line, which I found to be due to the presence of too many ells.

After making changes as indicated in the accompanying illustration, Fig. 3, the pounding ceased. R. F. M.

I WOULD SUGGEST that C. W. A. break out his feed line at the elbow on the right hand lower corner of his

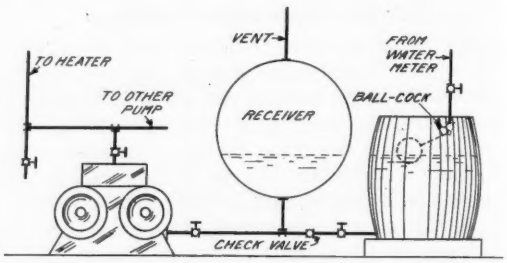


FIG. 2. SCHEME OF CONNECTIONS TO INSURE A CONTINUOUS SUPPLY OF MAKE-UP

right boiler and insert a tee, run his pipe line directly from his heater to this tee, then run his line from the tee to the riser between his boilers (or rather the feed to left boiler) breaking out that tee and insert an elbow.

Remove all surplus pipe and connections that encircle the boiler's front. I do not think it essential to have the air chamber and should remove it, as he says he is pumping hot water. An air chamber on a hot water pump, in my experience, has been detrimental to the working of the pump; because if pumping very hot water it will fill with steam and the pump will race.

Regulating valves, check valves and riser are to remain the same.

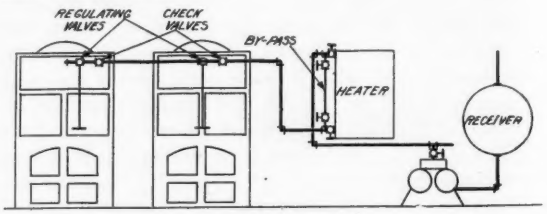


FIG. 3. R. F. M.'S ARRANGEMENT OF FEED LINE BY MEANS OF WHICH POUNDING WAS ELIMINATED

While I do not guarantee that the remedy I suggest will stop the pound, it is worth while to try.

M. S. W.

Repairing Leaky Boiler

IN THE Nov. 1 issue, page 897, F. J. H. says his boiler leaks at center seam just above the brickwork—rather a queer way of describing location of a leak—and asks whether it is dangerous. The answer says center seam above bridge wall.

I have had a boiler leak at center seam, so called, when longitudinal seam was correct. Again, in a two-course return tubular boiler a leak in the girth seam

over the bridge wall could have been called center seam. In my opinion, center seam is absolutely incorrect. In case of seam leak in a longitudinal seam, it may be very dangerous, as in a lap-welded boiler. Grooving may have reduced thickness of sheet to a dangerous degree, or it may require only calking. In the girth seam a leak, often caused by deposits of scale, oil, etc., or by action of chemicals in the coal striking directly against this seam, may or may not be dangerous. Fire cracks if short, are not particularly dangerous if attended to at once by a competent boilermaker, or again calking may be all that is necessary; loose rivets may be found, the remedy being obvious to an experienced engineer.

In short, my advice to F. J. H. would be to consult an engineer or boilermaker, as he seems to be in doubt on a subject on which he certainly should not need advice if he is an engineer. JAMES C. LEE.

Heating System Design Problem

WE ARE about to erect a new 35-room hospital building and wish to inquire as to the kind of heating system you would recommend. Other buildings now in use are heated with exhaust steam from our engines and pump in connection with a feed-water heater of the open type. The back pressure carried ranges from 1 to 5 lb. and the system is of the gravity return type.

The new building, which is about 300 ft. from the entrance of the boiler room, is so located as to be below both the feed-water heater and the return line.

Would you advise the installation of a vacuum system?

A. J.

A. The heating returns from present building are discharged into an open heater and pumped from there to the boilers. The returns pass into the heater by gravity.

The new building, being so low that the returns cannot be charged into the heater by gravity, will need some arrangement to help the condensation up into the heater. This may be done as suggested in your letter, by installing a complete vacuum system in that building, or it may be arranged to keep the same system in that building as the others, by installing a lifting trap of the Bundy or Crane Tilt style, to take care of the returns. From the amount of information given, it would seem that this arrangement would be the most satisfactory, as the trap could be placed as low as necessary in the building and would be entirely automatic in its action and would not require much attention.

A supply of medium pressure steam would be needed to operate the trap. A check valve on the vent pipe from the lifting trap would help some, effectually stopping any inrush of air which occurs after discharging by the condensation of steam left in the body of the trap. This creates a partial vacuum, which naturally helps to draw the condensation into the trap.

The vacuum system without any doubt would work well and all air valves would be eliminated, also smaller supply pipes could be used; but there would be pump troubles and annoyance from cylinder oil which would be needed to be used with the steam pump. If you have electricity which is on for 24 hr., then an electric, motor-driven vacuum pump may be used in place of the steam pump. The only drawback would be a higher first cost. With this system, radiator traps would be required for every radiator and coil, and an air separator would be needed for the discharge of the pump.

In the opinion of the writer, there is no difference in efficiency between the two systems. If you will send to the makers of any of the lifting traps, they will be glad to give you catalogs showing the proper installation of a trap for such work.

S. E. BALCOME.

Care of Idle Boilers

WHAT IS the best remedy to stop internal rusting of boilers that are not in continual operation, but left empty several months at a time? A. L.

A. We would suggest the following: If a boiler is to remain idle for some time its deterioration may be much more rapid than when in service. If the period for which it is to be laid off is not to exceed three months, it may be filled with water while out of service. The boiler should first be cleaned thoroughly, internally and externally, all soot and ashes being removed from the exterior of the pressure parts and any accumulation of scale removed from the interior surfaces. It should then be filled with water, to which five or six pails of soda ash have been added, a slow fire started to drive the air from the boiler, the fire drawn and the boiler pumped full. In this condition it may be kept for some time without bad effects.

If the boiler is to be out of service for more than three months it should be emptied, drained and thoroughly dried after being cleaned. A tray of quicklime should be placed in each drum, the boiler closed, the grates covered and a quantity of quicklime placed on top of the covering. Special care should be taken to prevent air, steam or water leaks into the boiler or on to the pressure parts, to obviate danger of corrosion.

Belt Glue Formula

WHAT IS the best way to glue an 8-in. and a 20-in. two-ply leather belt? E. S.

A. A satisfactory glue for cementing leather belts consists of two parts Page's liquid fish glue and one part Russian liquid isinglass.

Industrial Engineering gives a belt cement recipe calling for equal parts of glue and American isinglass, which are allowed to soak in water for 10 hr. The mixture is then brought to the boiling point and pure tannin added until it has the appearance of the white of an egg. This glue is applied hot to the surfaces of the splice.

MATERIALS recently removed from the export conservation list by the War Trade Board include the following of special interest to the power plant industry: Mica and mica splittings; rubber, including balata, crude, and gutta; tin as block, metallic ore or plate.

Also the following have been removed from the list of restricted imports: All salts of soda; electric lamps; grease; infusorial earth for insulation; nickel; zinc.

POWER PLANT ENGINEERING

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The Engineer's Future

Just now the engineer is in the limelight and is extolled for his achievements which have helped to win the war. Not half or a quarter has yet been told. Plants for war material and supplies that had been months in building were just beginning to produce or were ready to operate when the armistice was signed. Many devices for checkmating and devastating the enemy were perfected, and would have been put into operation, had hostilities continued a few months or even weeks.

In practically every work that the engineer has been called upon to perform, he has made good. Where failures have occurred, they have been due largely to the tremendous problems of organization and distribution which were handled by executives who were without engineering training or experience.

From the very nature of his work an engineer in any line learns to plan carefully, foresee obstacles and difficulties, devise ways to overcome them, and then make sure that his plans do not miscarry. If an unexpected condition arises he must meet it, change his plans accordingly or make new ones. He must work with the material and men at hand and get results. Only results count, and he knows that materials and Nature's laws cannot be changed by his wish, nor are the best of intentions an excuse for failure. It is his business to know what he is expected to accomplish and to do it.

The record of the war proves that he has met requirements in a material sense, and surely nobody doubts that in personal bravery under the most trying conditions, engineers have shown as great a spirit of bravery and self sacrifice as any body of men in either military or civilian service. Witness the men who have built roads and bridges under fire of heavy shells that the men in the trenches might be supplied with food and ammunition—those who have stood fast in flooded stokeholds of sinking ships until all hope of escape was past—men who were on important government work, breaking under long hours of strain, and when cautioned to ease up have replied, "My country needs this work done. If it is my last job on earth, I will go on until I finish it."

Everybody agrees that engineers have made good, and proved their fitness for big things.

What of the future? Will engineers drop back into their former position of men in the ranks or subordinate officers, leaving the big commands to other professions, to politicians and to business men? President Main in his address to the A. S. M. E. gives the following warning:

"As a class engineers have been extremely modest in their relations with business and public affairs. This has been a natural condition largely due to the education and training which they have received. The education has been along rather narrow and restricted lines of scientific work, leaving out almost entirely the broader studies of literature, common law, economics, business methods and the humanities. There is usually not much opportunity for broadening out, for it is necessary for a man, if he expects to keep abreast with the development of his profession, to spend nearly all of his surplus energy in reading and studying along the very lines which he followed in school.

"Notwithstanding this, it is wise to carry along a course of reading on broadening subjects and to have an interest in affairs which are wholly outside the scientific line of study, and to be identified with engineering and scientific societies in order to get the broadest outlook of life possible. It is for this reason, in order to get a broader aspect of life and acquire a taste for wider reading and study, that it is of advantage for a young man who is to follow some scientific pursuit to take an academic course before he takes his scientific course.

"I realize the impracticability for many men to spend so much time in preparation for their life work, but it is almost essential that a man should very early in his career acquire some knowledge of business principles and should endeavor to broaden himself so as to be able to fill with fair satisfaction the position that properly belongs to him in his profession and in the world.

"It should be the aim of the engineer to render the best possible service considered in a broad sense. It should be based on facts and not theories or suppositions, and upon scientific laws, which if properly applied will give satisfactory results. Nothing should be taken for granted, and the work or statements of others should be carefully checked before being adopted.

"The success of a man will depend upon his ability to produce results in an expeditious manner, which shall be accurate, and in which good judgment has been used, so that the finished product, if it be a physical structure, will be adapted to the use to which it is to be put and shall have been accomplished at a reasonable expenditure. If it be a plan for action it shall be clear and concise and adaptable to the purpose for which it is intended.

"He should be able to understand men and to know them. He should be willing to share his knowledge with his fellow engineers and inasmuch as he will do this through the society, or other similar means, his interests and outlook will broaden and the return to him will be multiplied. Integrity and perseverance in work and business and fairness and justice to all will in the long run count for more than brilliancy in attainments. Withal he must have a good stock of imagination and judgment in the application of fundamental principles.

"The true success of a man is not measured by the accumulation of money, but by the success of accomplishment of work which adds something to the general good for mankind and for the advancement of the profession."

Others have stated and are emphasizing like truths. We must know well our own line of work to be successful as engineers. But to succeed as men we must know men, the principles of economics, business methods, and the workings of the world about us.

Who shuts himself in a closet may succeed in his undertaking, but it will have little relation to the progress or needs of the world. The engineering profession will achieve importance according to the achievement of its individual members and their collective interest in public affairs. The man, as an individual, must make himself worthy to be entrusted with large responsibility; but the association or society is the means by which the profession as a whole, and its foremost members will be brought into their rightful places in governmental affairs and executive positions.

In the future, engineers should be as frequent and as prominent as lawyers, doctors, professors or business men on public committees and in public office. This can be accomplished if each engineer gets outside his rut—makes the most of himself as a man—and then cooperates with his fellow engineers to see that those fitted by natural endowment and attainments for high leadership are given the recognition and positions that they deserve.

We have been called upon during the war for large service, and have served well. It is our duty to ourselves, our profession and our communities to make sure that like opportunity for service and like successful performance continue in the future time of peace.

Power Factor Correction—A Necessity

Engineers in charge of plants supplying alternating current service realize the detrimental effects of low power factors. Frequently and generally, however, the regulation of this is somewhat beyond their control, but it is certain that with proper presentation any recommendations which they may make with a view toward the elimination of this evil will be acted upon by those responsible for the operation of the distribution system.

Except under ideal conditions unity power factor is not possible of attainment, but with proper arrangement, loading of machines and operation, values in excess of 90 deg. lag or lead may be realized. Underloading of all types of alternating-current apparatus will tend to lower the power factor of the entire system, and especially so if the motors supplied with energy are employed in connection with hoists, textile mill machines and reciprocating pumps and compressors. Line shafts driven by induction motors are frequently responsible for power factor troubles, as is also the improper use of starting and speed control apparatus.

Use of overexcited synchronous motors and other forms of equipment tending to draw leading line currents will correct conditions caused by highly inductive loads. The employment of such apparatus is, however, not always possible, and it is therefore necessary for the man in charge to determine ways and means whereby, with proper arrangement and operation of existing equipment, he can most readily boost the power factor of the system and thereby avoid heavy losses.

Where individual motors operating normally considerably under load are employed materially improved results may be secured by substituting a smaller machine, taking care of momentary peaks by means of a sufficiently heavy flywheel attached to the motor shaft. A study of load conditions may also reveal the necessity of utilizing group or partial group drive, the arrangement being such as will insure operation of the motor at or near rated capacity.

Index for 1918

The Index for Volume XXII of Power Plant Engineering is now prepared and will be sent free to subscribers upon request.

A New Automatic-Cleaning Under-Feed Stoker

A NEW type of automatic-cleaning under-feed stoker similar to the standard Jones Under-Feed Stoker, but which in addition has been made self-cleaning, has been developed by the Under-Feed Stoker Co. of America.

Coal is fed into the hoppers, either by gravity from storage above or by hand. The steam cylinder below and in front of the hopper operates a ram and pusher rod. As this steam-operated ram moves in toward the fire it pushes a charge of fresh coal from the hopper into the retort, or coal magazine, which supports the fuel bed. As the coal is pushed into the retort it moves the previous charge of coal slightly backward and upward, thus keeping fresh coal fed into the fuel bed from below. As this coal is gradually forced upward the heat from the incandescent zone above drives off the volatile gases from the fresh coal before actual burning

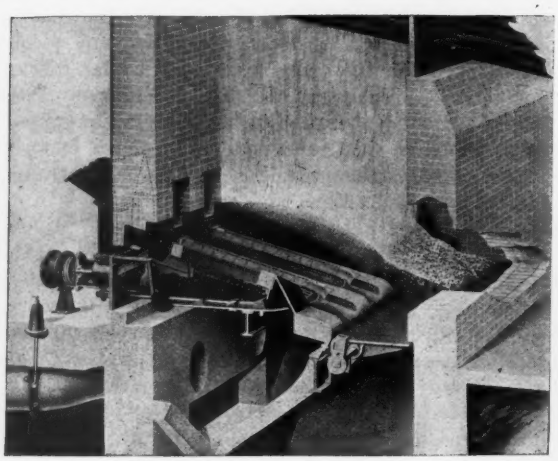

FIG. 1. THE UNDER-FEED STOKER WITH DUMP PLATE IN POSITION

takes place. These gases mix with the air admitted through the tuyeres, and the mixture passes upward through the hot fuel. The coke, which is left, is forced by the new fuel coming in to the upper part of the fuel bed (the incandescent zone), where it burns with the gas coming up from below, giving a clean, hot, coke and gas fire.

As the coke burns the intermittent movement of the fuel, caused by the feeding of the fresh coal from below, moves the whole burning fuel bed with ash and refuse slowly toward the rear. The movement is primarily caused by the intermittent upward and backward motion of the fuel resulting from the steam ram action. This backward movement, assisted by the pusher rod and blocks, carries the whole fuel bed slowly, without sliding or rolling, toward the rear as though on a conveyor, so that when the fuel bed reaches the dump plate at the rear the coal is entirely burned and nothing is left but dead ash. This very effectively keeps the fire clean of all ash and refuse and prevents the "avalanching" of burning fuel onto the dump plate. As the refuse accumulates on the balanced dump plate at the rear of the furnace the plate is dropped, which dumps the ashes into the pit below. This is the only manual operation necessary.

Air supply is automatically controlled by the steam pressure, and the coal supply is under the same control, but is subject to independent regulation. A drop in steam pressure quickly brings increased fuel and air, which builds up the pressure, while an increase in pressure brings a lower fuel and air supply, which cuts down the pressure. This system is so immediately responsive to change in load that an even, steady pressure is maintained regardless of variations in steam load. The flow meter chart and the pressure chart which are

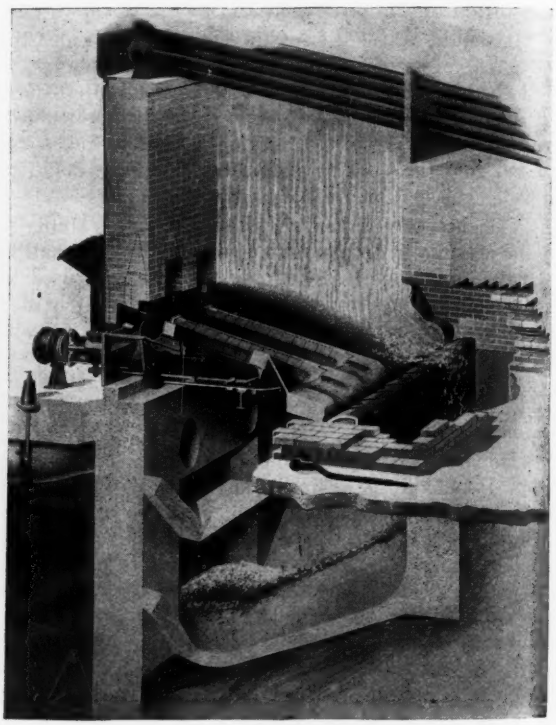

FIG. 2. THE UNDER-FEED STOKER WITH DUMP PLATE DROPPED

shown were taken over the same period of time and show the uniform pressure that is maintained even under widely varying load conditions. No matter how heavy or how sharp the demand for steam may be, the pressure is uniform.

Wide range of operation of the coal and air supply which is available with this equipment, together with the fact that each retort in a battery is operated independently of the others, gives extreme flexibility. The shape and size of the retort and coal-feeding apparatus are such that, when necessary, a maximum of coal can be fed into the stoker. Tuyere openings are so designed and arranged that plenty of air can be supplied to burn the coal, which gives a large coal burning capacity per square foot of furnace area. In plants where there

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

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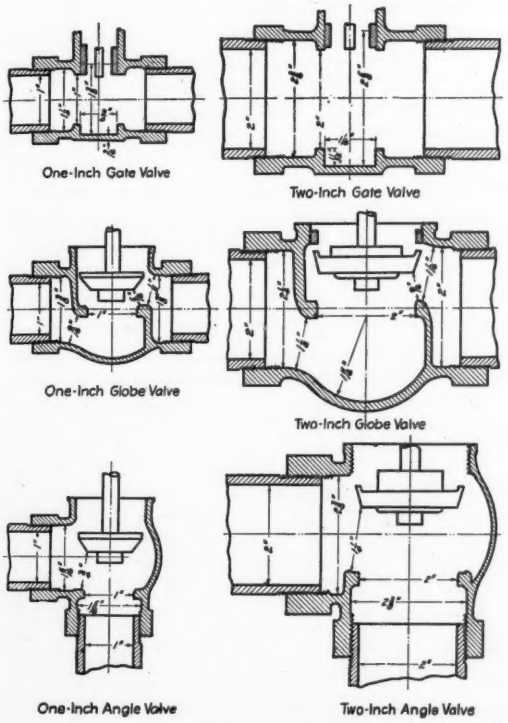
POWER PLANT ENGINEERING

LONGITUDINAL SECTIONS OF VALVES TESTED



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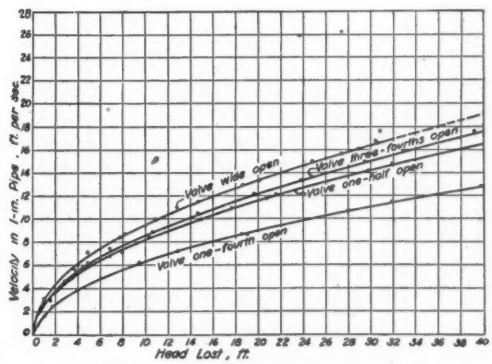
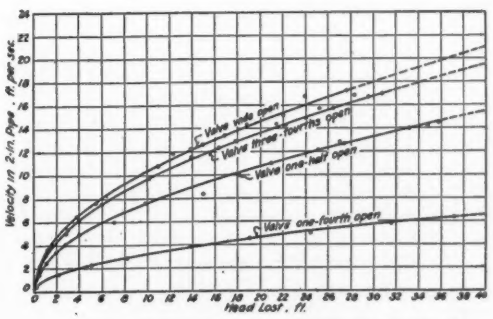


CURVES SHOWING THE RELATION BETWEEN THE VELOCITY AND HEAD LOST IN 1-INCH GLOBE VALVE



CURVES SHOWING THE RELATION BETWEEN THE VELOCITY AND HEAD LOST IN 2-INCH GLOBE VALVE

POWER PLANT ENGINEERING

NUMBER OF 9-IN. ARCH BRICK REQUIRED TO TURN VARIOUS CIRCLES

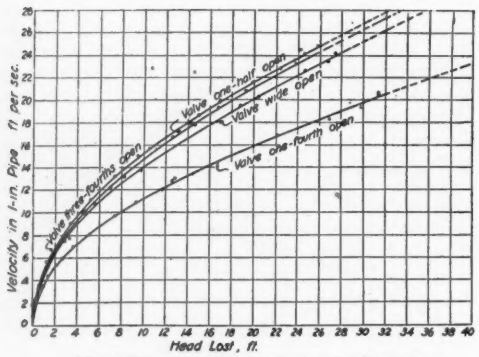
Inside Diameter	No. 3 Arch	No. 2 Arch	No. 1 Arch	Straight	Total
0 ft. 6 in.	19	.....	.....	.....	19
1 " 0 "	12	15	.....	.....	27
1 " 6 "	4	30	.....	.....	34
1 " 9 "	.....	38	.....	.....	38
2 " 0 "	.....	34	8	.....	42
2 " 6 "	.....	26	23	.....	49
3 " 0 "	.....	19	38	.....	57
3 " 6 "	.....	11	53	.....	64
4 " 0 "	.....	4	68	.....	72
4 " 3 "	.....	.....	76	.....	76
4 " 6 "	.....	.....	76	4	80
5 " 0 "	.....	.....	76	11	87
5 " 6 "	.....	.....	76	19	95
6 " 0 "	.....	.....	76	27	103
6 " 6 "	.....	.....	76	34	110
7 " 0 "	.....	.....	76	42	118
7 " 6 "	.....	.....	76	49	125
8 " 0 "	.....	.....	76	57	133
8 " 6 "	.....	.....	76	64	140
9 " 0 "	.....	.....	76	72	148
9 " 6 "	.....	.....	76	79	155
10 " 0 "	.....	.....	76	87	163
10 " 6 "	.....	.....	76	94	170
11 " 0 "	.....	.....	76	102	178
11 " 6 "	.....	.....	76	109	185
12 " 0 "	.....	.....	76	117	193

Evens & Howard Fire Brick Co.

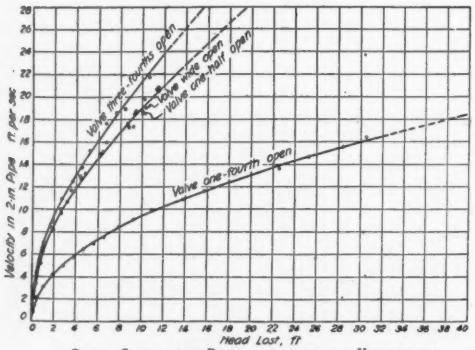
POWER PLANT ENGINEERING

NUMBER OF 9-IN. KEY BRICK REQUIRED TO TURN VARIOUS CIRCLES

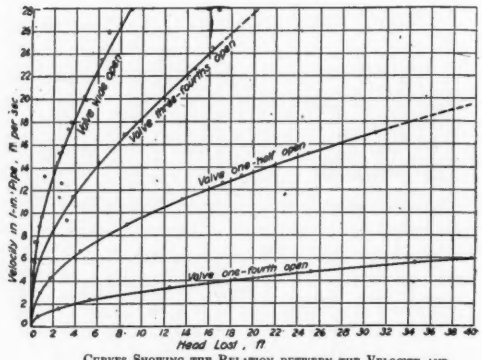
Inside Diameter	No.4 Key	No.3 Key	No.2 Key	No.1 Key	Straight	Total
1 ft. 6 in.	25	....	....	....	.....	25
2 " 0 "	16	13	....	....	.....	29
2 " 6 "	9	25	....	....	.....	34
3 " 0 "	....	38	....	....	.....	38
3 " 6 "	....	29	13	....	.....	42
4 " 0 "	....	21	25	....	.....	46
4 " 6 "	....	12	38	....	.....	50
5 " 0 "	....	5	50	....	.....	55
5 " 3 "	....	....	57	....	.....	57
5 " 6 "	....	....	55	4	.....	59
6 " 0 "	....	....	50	13	.....	63
6 " 6 "	....	....	46	21	.....	67
7 " 0 "	....	....	42	29	.....	71
7 " 6 "	....	....	38	38	.....	76
8 " 0 "	....	....	34	46	.....	80
8 " 6 "	....	....	29	55	.....	84
9 " 0 "	....	....	25	63	.....	88
9 " 6 "	....	....	21	71	.....	92
10 " 0 "	....	....	17	80	.....	97
10 " 6 "	....	....	13	88	.....	101
11 " 0 "	....	....	9	96	.....	105
11 " 6 "	....	....	4	105	.....	109
12 " 0 "	....	....	....	113	.....	113
12 " 6 "	....	....	....	113	4	117
13 " 0 "	....	....	....	113	9	122
13 " 6 "	....	....	....	113	13	126
14 " 0 "	....	....	....	113	17	130
14 " 6 "	....	....	....	113	21	134
15 " 0 "	....	....	....	113	25	138



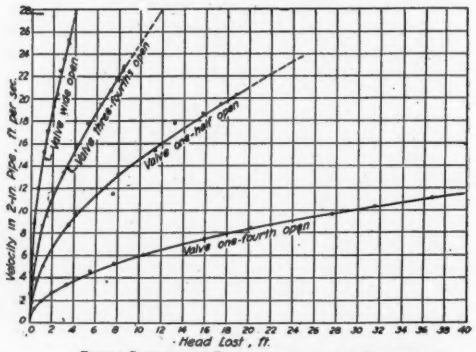
CURVES SHOWING THE RELATION BETWEEN THE VELOCITY AND HEAD LOST IN 1-INCH ANGLE VALVE



CURVES SHOWING THE RELATION BETWEEN THE VELOCITY AND HEAD LOST IN 2-INCH ANGLE VALVE



CURVES SHOWING THE RELATION BETWEEN THE VELOCITY AND HEAD LOST IN 1-INCH GATE VALVE



CURVES SHOWING THE RELATION BETWEEN THE VELOCITY AND HEAD LOST IN 2-INCH GATE VALVE

Univ. of Ill. Bulletin No. 105.

NUMBER OF 9 BY 6 BY 3-IN. KEY BRICK REQUIRED TO TURN VARIOUS CIRCLES

Inside Diameter	No. 2 Key 9x(6-4⅜)x3	No. 1 Key 9x(6-5⅝)x3	Squares	Total
6 ft. 0 in.	47	.....	.....	47
6 " 6 "	44	6	.....	50
7 " 0 "	42	12	.....	54
7 " 6 "	38	19	.....	57
8 " 0 "	34	26	.....	60
8 " 6 "	31	32	.....	63
9 " 0 "	27	39	.....	66
9 " 6 "	23	46	.....	69
10 " 0 "	20	52	.....	72
10 " 6 "	16	59	.....	75
11 " 0 "	13	66	.....	79
11 " 6 "	10	72	.....	82
12 " 0 "	6	79	.....	85
12 " 6 "	3	85	.....	88
13 " 0 "	.....	91	.....	91
13 " 6 "	.....	91	3	94
14 " 0 "	.....	91	6	97
14 " 6 "	.....	91	10	101
15 " 0 "	.....	91	13	104

NUMBER OF 13½-IN. KEY BRICK REQUIRED TO TURN VARIOUS CIRCLES

Inside Diameter	No. 2 Key	No. 1 Key	Straight	Total
6 ft. 0 in.	52	.....	.....	52
6 " 6 "	48	7	.....	55
7 " 0 "	42	16	.....	58
7 " 6 "	37	24	.....	61
8 " 0 "	33	32	.....	65
8 " 6 "	28	40	.....	68
9 " 0 "	23	48	.....	71
9 " 6 "	18	56	.....	74
10 " 0 "	12	65	.....	77
10 " 6 "	7	73	.....	80
11 " 0 "	2	81	.....	83
11 " 3 "	.....	85	.....	85
11 " 6 "	.....	85	2	87
12 " 0 "	.....	85	5	90
12 " 6 "	.....	85	8	93
13 " 0 "	.....	85	11	96
13 " 6 "	.....	85	14	99
14 " 0 "	.....	85	17	102
14 " 6 "	.....	85	21	106
15 " 0 "	.....	85	24	109

Evens & Howard Fire Brick Co.

NUMBER OF 9-IN. WEDGE BRICK REQUIRED TO TURN VARIOUS CIRCLES

Inside Diameter	No. 2 Wedge	No. 1 Wedge	Straight	Total
2 ft. 3 in.	57	.....	.....	57
2 " 6 "	49	11	.....	60
3 " 0 "	38	30	.....	68
3 " 6 "	26	50	.....	76
4 " 0 "	12	71	.....	83
4 " 6 "	.....	91	.....	91
5 " 0 "	.....	91	8	99
5 " 6 "	.....	91	15	106
6 " 0 "	.....	91	23	114
6 " 6 "	.....	91	30	121
7 " 0 "	.....	91	38	129
7 " 6 "	.....	91	45	136
8 " 0 "	.....	91	53	144
8 " 6 "	.....	91	60	151
9 " 0 "	.....	91	68	159
9 " 6 "	.....	91	76	167
10 " 0 "	.....	91	83	174
10 " 6 "	.....	91	91	182
11 " 0 "	.....	91	98	189
11 " 6 "	.....	91	106	197
12 " 0 "	.....	91	113	204
12 " 6 "	.....	91	121	212
13 " 0 "	.....	91	128	219
13 " 6 "	.....	91	136	227
14 " 0 "	.....	91	143	234
14 " 6 "	.....	91	151	242
15 " 0 "	.....	91	158	249

is a wide variation in load, or where heavy overloads are sometimes necessary, this flexibility and coal burning capacity are of extreme importance.

Observation doors built in the front setting opposite each row of tuyeres enable the firemen to watch the fire and keep it in good condition. The operator can work through the doors and down each row of tuyeres with a slice bar should any small clinker formation be noticed on the tuyere blocks. If a hole is found in the fire it can be filled by feeding more coal to that retort. As each steam cylinder can be operated independently of the others, the coal supply to each section of the fire is subject to individual control, so that a perfect fuel bed can be maintained at all times.

Intermittent breaking up of the fuel bed as fresh coal is supplied prevents the formation of large clinkers and promotes complete combustion. The sieve test shows that approximately 75 per cent of the total ash goes through a 2-in. mesh, and 85 per cent through an 8-in. mesh; and analysis of the ash shows but a negligible amount of combustible. There are no clinker formations on the bridge wall, because there is no fire on the dump plate. Clinker on the side walls is prevented by the side tuyeres.

Action of the steam ram is not positive, but can be stopped entirely by any foreign substance that may get into the hopper. When this substance is removed the ram operates again. Nothing is broken and the stoker need not be stopped, although if necessary or desirable any retort in a battery of retorts can be shut down, as each one is operated independently of the others. The tuyere blocks will burn out, but it is very easy to replace them, as each block is held in the retort by means of a rod which can be removed easily from the front of the furnace, so that the new tuyere block can be slipped in place without disturbing the fire to any extent.

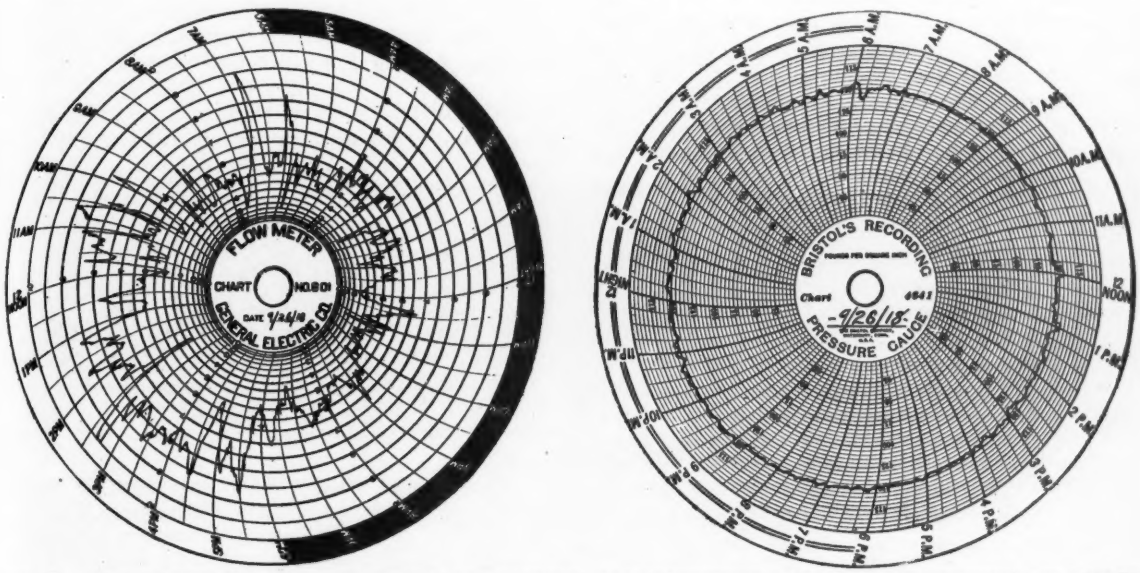


FIG. 3. FLOW METER AND PRESSURE CHARTS FOR VARYING LOAD CONDITIONS WITH UNDER-FEED AUTOMATIC STOKER

News Notes

THE FULLER ENGINEERING CO., Designing and Constructing Engineers, Allentown National Bank Building, Allentown, Pa., announce that Frederick A. Scheffler, formerly connected with the New York offices of the Babcock & Wilcox Co., has now become associated with them and will make his headquarters at their New York office, 50 Church St., Hudson Terminal, New York City, New York. The company is making a specialty of applying the pulverized coal method of firing to boilers of all kinds for generating power; and Mr. Scheffler will be in a position to furnish complete information regarding the cost of installation, preparation, and probable economies obtainable by the adoption of this method of firing coal.

H. W. CLARKE, who until Dec. 15 had been connected with the Advertising Service Department of the McGraw Hill Co. at Chicago, has been appointed manager of advertising for the Chicago Pneumatic Tool Co., Chicago, Ill. Mr. Clarke has been identified with the engineering advertising field for several years. Prior to his connection with the McGraw Hill publications he spent 8 yr. with the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., part of the time as a member of the sales and publicity departments and later as Western publicity representative, with headquarters at Chicago.

WALTER N. POLAKOV, Consulting Engineer, announces the founding of Walter N. Polakov & Co., Inc., consultants in power production, methods, industrial investigations, labor problems, scientific record systems, and production accounting. With the close of hostilities, a number of capable engineers formerly associated with him have joined the staff of the corporation at 31 Nassau St., New York.

CLARAGE FAN CO., Kalamazoo, Mich., is glad to announce the return of Lieutenant Louis O. Monroe to the organization. Lieutenant Monroe who, previous to entering the service was in charge of the Chicago office, will assume duties as Manager of Sales and Chief Engineer for this company on Jan. 1.

THE LORAIN COUNTY ELECTRIC CO. announces the death of Murray Copes Conley at Elyria, Ohio, on Dec. 21, 1918.

Catalog Notes

A. S. CAMERON Steam Pump Works, 11 Broadway, New York, has issued a 12-page bulletin on pumps for marine service. This bulletin shows sectional and complete views, as well as description and tables, that will be of service to anyone interested in the subject of marine pumps.

HISTORY AND DEVELOPMENT of ball bearings are discussed in a new catalog from The Hess-Bright Mfg. Co., of Philadelphia; also lubrication of ball bearings, advantages of Hess-Bright ball bearings and their use in the automobile, airplane, machine tools, flour and feed milling machinery, wood-working machinery, electrical machinery, axle lighting generators, mining locomotives and on street railways.

THE NEW CATALOG of Coppus Engineering & Equipment Co., Worcester, Mass., explains the principle and advantages of the Coppus Turbo Blower for undergrate draft and other industrial purposes, stating a theory of mechanical draft in connection with combustion in a thorough and concise manner. Different types of the Coppus Turbo Blower are described and illustrated.

STORAGE and distributing systems for oils, gasoline, light paint, varnish and similar products, manufactured by Wayne Oil Tank and Pump Co., Fort Wayne, Ind., are described in that company's latest booklet.

THE PREVENTION of Rusting or Corrosion of Iron and Steel is the subject of a booklet lately issued by Dearborn Chemical Co., of Chicago, describing the company's protective coatings, cleaning preparations, and quenching, drawing and cutting oils.

RICHMOND MODEL BOILERS for steam and water heating are illustrated and described in a booklet from Richmond Radiator Co., 1480 Broadway, New York.

A FEW OF the brass valves manufactured by The Ohio Brass Co., Mansfield, O., are illustrated in the latest circular from that company.

HOW TO START A TRAINING DEPARTMENT IN A FACTORY is the subject of a bulletin concluding a series of publications issued by the Section on Industrial Training, Committee on Labor, Council of National Defense. This bulletin by Frank Lawrence Glynn, director of training for the Curtiss Aeroplane Co., outlines the method, after the organization of the Training and Dilution Service, of establishing a training department for the Curtiss Aeroplane Co. at Buffalo, N. Y.

NONPAREIL high pressure blocks and cement for enameling, japanning and drying ovens, boilers, steam drums, feed-water heaters, tanks, breechings and other heated surfaces, are described in a 20-page booklet recently published by Armstrong Cork & Insulation Co., Pittsburgh, Pa.

A folder from the same company relates to sanitary drinking water systems for industrial plants.

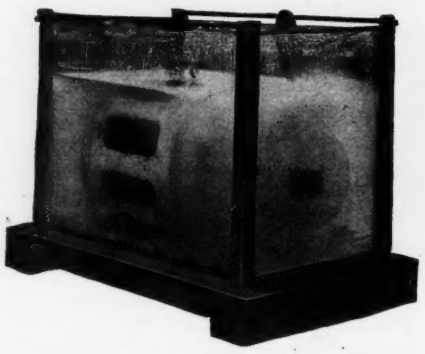
FUEL OIL and Its Use, a new booklet from Tate, Jones & Co., Inc., of Pittsburgh, Pa., contains tables showing the amounts of different fuels required to equal each other on the basis of heat units, calorific values of various oils and other tables. Oil storage and feeding, piping layouts and burners are discussed, followed by description of Tate-Jones oil burners and steam-driven pumping, heating and regulating systems.

INSULBRIX, a specially prepared cellular insulating refractory brick which keeps heat in or out of furnaces or other structures, is described in a folder from Quigley Furnace Specialties Co., 26 Cortlandt St., New York.

Trade Notes

FOR THE PAST 3 yr. the Lincoln Electric Co. has operated a 110-v. induction motor, at its main office at Cleveland, under water without damage to winding. The motor is from stock, and the purpose of the demonstration was to show the stability and water proofing qualities.

An occasional test of 1500 v. to determine the deterioration of the insulation has been made and so far no defects have developed. It is proposed to continue this demonstration until the motor shows defects.



WALWORTH MANUFACTURING CO. has recently purchased the business of Hunter & Dickson Co. at 241-247 Arch St., Philadelphia, Pa., and after the first of the year will operate it as a branch office.